REGD NO. M. 2799.

Current Science

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CONTENTS.

The Indian Institute of Science.

IN view of the impending appointment of the second Quinquennial Reviewing Committee, a brief survey of the development and activities of the Indian Institute of Science, Bangalore, during its life of twenty-five years, may assist in creating sympathetic and enlightened public opinion. This will provide a favourable background, rendering the task of the Committee perhaps less tedious and more congenial ; it may even be found indispensable to the formulation of a definite policy for promoting schemes of reform and expansion, such as the Committee may deem desirable to recommend on the conclusion of their labours. The first Quinquennial Reviewing Committee have, in more than one section of their report, drawn attention to the prevailing public ignorance of the work and resources of the Institute, and have also adversely commented on the general misconception among members of the Court regarding the economic activities of the different departments. Such ignorance and misunderstanding, if allowed to persist, would favour the growth of public prejudice affecting the character and fair reputation of the Institute, although there is ample testimony of honourable work steadily pursued in a spirit of disinterested service to the country. It is true that the Pope Committee reported in 1921 abundant evidence that there existed in many quarters "a strong feeling of disappointment and dissatisfaction" with the then existing condition of the Institute ; and if such a feeling still prevails in the public mind, it must be almost entirely due to general ignorance of the steps that have since been taken to remove partially or entirely the causes which led the Committee to record the adverse comment. If, however, there is still a source of dissatisfaction either within the precincts of the Institute or outside, we think it must arise from defects inherent in its organisaton as well as from lack of a sound and definite policy, understood by all concerned, in regard to both the academic and the administrative spheres of this great foundation. In a short contribution on the Indian Institute of Science published in this *Journal* (October 1932), Alchymist observes that "with this provision (resources becoming available) the future, to which we now look for progress and expansion at least comparable with those of the last fifteen years, is hopeful". Manifestly the writer of the article is favourably

impressed by the advances made by the Institute during this period in the different branches of its activity. Sometime ago it was pointed out in an article in *Nature* (April 29, 1933) that "even if such an Institute were established in Great Britain, where the distances are not of the same continental order, it may be doubted if it would attract as many science graduates taking courses of advanced study and training for research as are now at Bangalore". This is a disinterested testimony to the increasing popularity and sound reputation of the Institute.

We have perused practically all the annual reports of the Council and have referred to almost all the volumes of the *Journal* of the Institute. They are probably the only authoritative documents which give information regarding the development of this institution, and when read in conjunction with the two Committee Reports reflecting the views and opinions of independent experts, we have all the materials necessary for forming a fairly correct judgment on the fundamental question of how far and in what manner the achievements of the Institute have fulfilled the aims and intentions of its founder, and also the intelligent expectations of the cultured public who look to the Institute for a lead in the economic and industrial life of the country. Judged by the ordinary academic standard, the Institute has a blameless record.

After briefly reviewing the administrative and financial matters of each year, Council Reports chronicle the departmental occupations of the Institute in a greatly abridged form, and their results are catalogued in the Appendices. To obtain a comprehensive and analytical view of the activities of the Institute, we propose to investigate the records for twenty years (1914–34), a period covered by the Pope and Sewell Committee Reports. During this period three departments, *viz.*, General and Organic Chemistry, Electrical Technology and Biochemistry,—were operating—and in 1934 the Department of Physics was instituted. The total volume of laboratory investigations undertaken in all these departments is reflected in the number of preliminary reports communicated to the Indian Science Congress, and in the number of papers published in the *Journal* of the Institute and in foreign scientific periodicals. In estimating these results, account must be taken also of consultative work in which the members of the staff and research scholars were engaged. Our analysis has yielded the following results. The Institute began to send its scientific papers to the Congress in 1916 and, up to 1934 has made 685 contributions. The *Journal* of the Institute first appeared in 1915 and so far 18 volumes containing 272 papers have been published. Information regarding the number of papers published in foreign journals is imperfect, but it is fair to assume that the number cannot be more than about a hundred, since until recently the policy has been to publish almost all the papers in the official organ of the Institute. We thus obtain a total exceeding 300 published papers. No indication is made in any of the official documents regarding the destiny of preliminary communications to annual sessions of the Indian Science Congress, but we have no doubt that all these researches were completed and their results published in the journals to which we have alluded.

During this period the total number of scholars who have undergone training or have conducted research in all the departments, including the recently instituted section of Physics, is 836 which includes about 250 students who qualified for certificates and diplomas in Electrical Technology. Of those who were engaged in research, only four students were elected to the Fellowship of the Institute, which is equivalent to the D.Sc. Degree of the Universities, and about 139 received the Associateship which represents the M.Sc. standard. The qualifying test for tangible recognition of work is obviously high, and it is in keeping with the character and reputation of the Institute. More than 30 per cent. of the scholars trained in various departments have been absorbed in industrial occupations and scientific professions, and the demand for such highly trained candidates must grow in the future with the industrial expansion in the country. During the period to which we have restricted our survey, the total income amounted roughly to Rs 109,84,902 and the expenditure to Rs. 103,88,233, nearly 50 per cent. of which was utilised in equipping the laboratories. According to the opinions expressed by the Pope and Sewell Committees, the scientific equipment of the laboratories for every description of research in the relevant subjects is perhaps unrivalled in India.

The evolutionary history of the Institute may conveniently be divided into three natural stages which we may characterise

as the periods of exploration, consolidation and action. Between the years 1911 and 1921, the Institute was practically engaged in equipping itself for the duties of a " new Institution entirely novel to the country and therefore without a fund of experience on which to draw "—a factor which must impose a serious handicap on its emergence at once as a foundation rich in traditions and in spectacular achievements. The Council was engaged during these ten years in a very full and thorough discussion of the numerous administrative and academic problems arising from the resignation of Dr. M. W. Travers and of Professor Rudolf at the end of the session 1913–14 ; the schemes prepared by the special Committee of the Council involving considerable expenditure for equipping the new department of Applied Chemistry and for extending other existing laboratories ; the refusal of the Government of India to grant extra financial assistance owing to the War and the failure of the efforts of the Council to secure a Director who could also assume the duties of a professor of applied chemistry. In 1915, when the affairs of the Institute were passing through a critical phase, the Indian Industrial Commission was appointed, and when Sir Thomas Holland and Sir Dorabji Tata met Sir Alfred Bourne in the year 1916, a memorandum was presented to the Commission suggesting that the Institute should form a nucleus for the development on a large scale of an Indian Institute of Chemistry. This proposal was not in consonance with the resolution of the Government of India (May 1909) that " they were of opinion that the idea of combining in one Institution and entrusting to a single staff of professors, both the teaching of science and the experimental development of new industries, was open to the obvious criticism that these two objects were in no way connected." The Holland Commission accepted the Memorandum of the Council because they discovered that the Institute had departed from the resolution of the Government of India and from the aims and objects of the founder of the Institute, and in a significant paragraph they wrote that, originally projected by the late Mr. J. N. Tata with the object of encouraging post-graduate study and training for research in pure physical science, the Institute has, in the course of a comparatively short career, developed a distinct tendency towards the study of problems which are likely to lead to results of immediate economic value, rather than towards the pursuit of investigations of purely scientific interest. As a result of this bias towards chemical industry, the Institute was invited to co-operate with the Indian Munitions Board in the work which that Board had undertaken towards utilising local resources for war, and such assistance necessarily implied the temporary suspension of normal work in the departments. This co-operation finally led the Council to the conviction that " the Institute should concentrate effort on industrial chemistry and endeavour to secure further funds towards that end " and owing largely to the influence of this conviction great progress was made in the years 1916-18 towards associating the work of the Institute with that of the industrial departments of Government. The progress made in the applied branches of chemistry is reported in detail in a monograph issued by the Institute on the ceremonial occasion of unveiling the statue of Mr. J. N. Tata, and led the Council and Government to reconsider the future policy and lines of development. The Pope Committee was appointed in 1921 and their report introduced the second phase in the life-history of the Institute which we call the period of consolidation.

Dr. M. O. Forster (now Sir Martin Forster) was appointed Director of the Institute in 1922 soon after the publication of the Pope Committee Report. In less than three years of his assumption of duties, three professors retired on reaching the age-limit ; Dr. Alfred Hay in December 1922, Dr. Gilbert J. Fowler in 1924 and Dr. J. J. Sudborough in June 1925, the vacancies being filled by Mr. J. K. Catterson-Smith, Dr. R. V. Norris and Dr. J. L. Simonsen, respectively. Dr. Forster's time and energies were devoted to examining the administrative and departmental problems adumbrated by the Pope Committee and to exploring the means of implementing, in so far as might be possible, their recommendations. In the department of Biochemistry, Dr. Fowler had established a distinguished school of research in several applied branches, and Dr. Norris proceeded to found new ones. Relieved from the influence exerted by war-conditions, practically all the departments resumed the pursuit of investigations in pure science, maintaining, however, such *liaison* with industrial problems as opportunity offered. Dr. Forster's administration will be remembered chiefly as a period of consolidation of the

moral and material resources of the Institute, in accordance with the proposal of expansion outlined in the Pope Committee report. It was also the period which witnessed the rapid evolution of departmental activities which created a suitable atmosphere for the next phase of development. Before Dr. Forster relinquished his office in March 1933, the Sewell Committee had reported.

Sir Venkata Raman, the new Director, assumed charge of his duties almost immediately. It must be remembered that Sir Venkata Raman was a member of the Pope Committee and had sat in the Council of the Institute for over seven years. In this respect the new Director had an advantage over his predecessors, *viz.*, that he entered upon his duties with a complete knowledge of the work of the Institute such as few could claim to possess. But they were not confronted with the difficulties which Sir Venkata Raman had to encounter. He had soon to face a deficit budget. The Physics Department had to be constructed and equipped. The proposals of the Sewell Committee had to be considered. In the meantime Dr. H. E. Watson and Professor F. N. Mowdawalla proceeded to other appointments. Dr. Watson, who was the senior member of the Institute Staff, had by his energy and character elevated the Department of General Chemistry to an honourable position, and some of his researches had led to the establishment of industries. His departure from the Institute is undoubtedly a great loss. Professor Mowdawalla was a former scholar of the Institute where he had conducted several investigations in the Department of Electrical Technology, and his place is to be filled by Mr. Kenneth Aston. In the Council Report for 1934–35 the Department of Physics organised by Sir Venkata Raman is shown as having produced 39 papers, General Chemistry 9, Organic Chemistry 14, Biochemistry 49 and Electrical Technology 15, in other words the total output of research during this one year was 127 papers. We had almost a paper for every three days emanating from the Institute. This is research in full action.

The Pope Committee deplored that "the Institute has lost in efficiency by reason of the fact that its policy and lines of development have never been defined with sufficient precision," and an examination of the Council Reports since 1922 does not disclose any comprehensive and clearly defined policy directed to the promotion of the welfare and progress of the Institute and of its relation to the economic and industrial life of the country. Perhaps the most important question which the Institute will be called upon to settle is whether it will continue to provide preliminary training in scientific methods and knowledge in its departments and also to hold certificate and diploma courses in Electrical Technology, particularly in view of the fact that almost all the Indian universities have instituted research departments both in theoretical and applied branches of science, in which work of a very high order is conducted, manifest from the number of papers published in India and abroad. In most of the universities, post-graduate work involves a considerable amount of training in research methods, and the M.Sc. Degree is awarded on the submission of a thesis on an original problem. In view of the rapid strides that universities and government research departments are making in the field of research, the Indian Institute of Science has to shape its academic policy to suit the altered conditions in the country.

The essence of this policy, as we conceive it, is that the Institute must find facts, while the public and government must find out how to use them. One of the main articles of such a policy would be to launch a campaign to convince the new legislatures and other bodies who control finance, that research is wealth, and that the greatest tributaries to it are chemistry and physics, through their contributions to agriculture, medicine, metallurgy and the entire range of manufacturing occupations. The second factor in this policy is to insist upon public recognition of the fact that the prosperity of a country in a competitive civilisation depends not so much upon the control of natural resources as upon the control of scientific processes. The work of the Institute in the field of fundamental research and industrial research should no longer be permitted to remain an inscrutable mystery to statesmen and administrators whose position in public life and whose influence in the legislative councils would be a material agent in establishing new research laboratories. The Institute is essentially a single organism, whose health and functional efficiency depend upon the harmonious cooperation of its different members, and in order to secure such co-ordinated effort and infuse a sense of collective responsibility,

the different departments must develop mutual interests and remove the spirit of exclusiveness. This is best done by the establishment of borderland branches of science, which would bind the several units into a single corporate body with common aims and purpose.

The question of the status of the Institute is discussed by the Sewell Committee. They have stated "that the Institute ought always to be in a position to provide such opportunities as cannot be obtained anywhere else in India; that it should do what no other institution can do; that it should maintain a position of pre-eminence; that it should acquire even a world reputation and that it should become a place of reference." The path to attaining this ideal is also indicated in the report, *viz.*, the personnel of the directorate, professoriate and staff, to which we would add finance. These admirable sentiments, however, are not in consonance with the theory elaborated by the Committee regarding the sources of revenue to be explored by the Institute. It seems to us that the preservation of the All-India or international character of the Institute depends upon the regional origin of its finances, its staff and students; and any suggestion of contribution by the provinces in proportion to the benefits received by their scholars must militate against the All-Indian status of the institution. On the other hand, contributions based on the financial capacity of each province irrespective of other considerations will invest the policy and outlook of the Institute with a national character. Each British Province and each major Indian State might endow a chair and support the laboratory attached. The late Mr. J. N. Tata never contemplated personal or communal benefit from the Institute which his munificence founded. The Institute is the cultural rallying point of the Indian Nation, and its structure is an indivisible unit. If the provinces, the Indian States and the industrial magnates consider it their patriotic duty, rendered in a spirit of pure altruism, to create and support associate professorships, readerships and lecturerships in appropriate branches of science, then it may be possible to release the funds of the Institute more freely for developing its international reputation, by inviting scientists of outstanding eminence such as the Sewell Committee contemplate, to associate themselves with the life and work of the institution. If it were only possible to induce such men to come to India—and it may not be difficult provided we have the resources—the universities, the government scientific departments and the industries would be glad to secure their co-operation and only then would the Institute be in "a position to do what no other Institution could do". It is gratifying that, with the limited funds at his disposal, Sir Venkata Raman has already taken the first step in this direction by inducing the Council to invite Professor G. Hevesy and Dr. Max Born to stimulate the work of the Institute; further development of this great institution must depend upon the financial support of provincial governments and of the Indian States.

Academy of the Natural Sciences of Philadelphia.

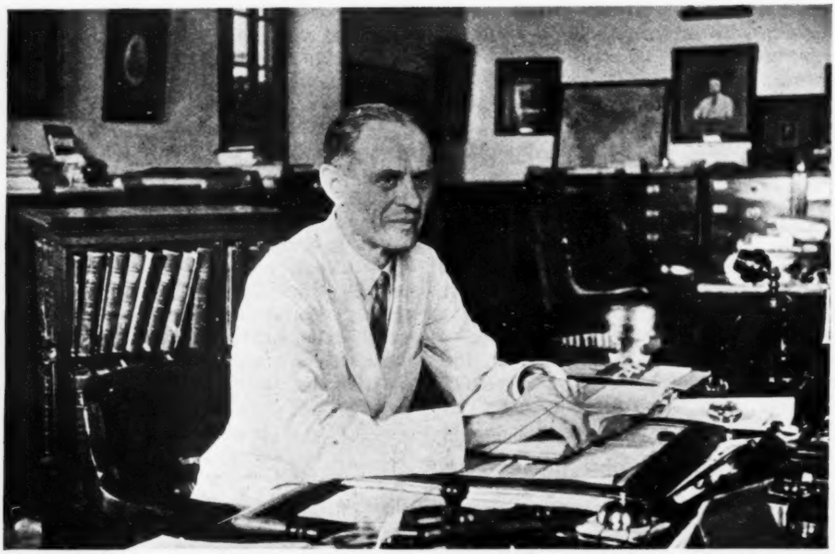
MUSEUM workers all over the world are familiar with the high standard of publications issued by the Academy of Natural Sciences of Philadelphia, which is maintained wholly by private endowments and contributions from members and friends. This Academy was founded in 1812 and has done great service in stimulating research in natural sciences in almost a century and a quarter of its existence. The 86th volume of its *Proceedings* for 1934 has been recently issued. It contains 17 contributions from well-known workers. Of these 15 are on zoological subjects dealing with Mammals, Birds, Reptiles, Amphibians, Fishes and Molluscs, and two small ones on botanical subjects. The interesting feature of this volume is that it contains contributions about the Zoological Results of the Third De Schauensee Siamese Expedition, of the Matto Grosso Expedition to Brazil in 1931, and Dolan West China Expedition of 1931. These expeditions account for 7 papers out of 15. Another remarkable feature of the series is that separates of the contributions presented in its *Proceedings* can be purchased at a small cost. There is a good index to the genera and species described and referred to in the volume. The full volume comprises 589 pages and 23 plates, mostly of molluscs. It is further illustrated with numerous drawings in the text. The price of the full volume is \$5·00 to subscribers and \$6·25 to others.

Sir Lewis L. Fermor, Kt., O.B.E., D.Sc., A.R.S.M., F.R.S., F.G.S., F.A.S.B., M.Inst.M.M.

AFTER thirty-three years' distinguished service to India, Sir Lewis Fermor will be retiring this month from the Directorship of the Geological Survey of India, and India will be losing one of her most distinguished scientists. We take this opportunity of paying our tribute to one who has laboured so well for the cause of Science in India.

Trained as a geologist at the Royal School of Mines under Prof. J. W. Judd, with a strong interest in metallurgy, Sir Lewis Fermor was appointed to the Geological Survey of India in 1902, at the time that Sir Thomas Holland assumed the Directorship of the Survey. His promise of exceptional ability was recognised when he was promoted to the grade of Superintendent in 1910, at the early age of 30.

Sir Lewis Fermor's first introduction to Indian Geology was given to him by the late Mr. E. W. Vredenburg, whom he accompanied into the field in Central India. It was on this occasion that Sir Lewis first came into contact with manganese ore deposits in the field, and it was probably due to this that in the following year Sir Thomas Holland, thinking it advisable to examine scientifically what was then already a flourishing industry, deputed Sir Lewis Fermor to investigate the manganese ore



Sir Lewis L. Fermor, Kt., O.B.E., D.Sc., A.R.S.M., F.R.S., F.G.S., F.A.S.B., M.Inst.M.M.

deposits of India. It is probable, however, that Sir Thomas Holland never visualised that this work would take six years to complete, and lead to the publication of a monumental memoir running to 1294 pages. In this great work, by which Sir Lewis is still best known outside India, manganese was treated from almost every point of view; and hidden away in this memoir there is a wealth of original observation, concerning not only manganese itself but also many related geological problems, which has frequently been overlooked. Of the many valuable results accruing from this work, one may specially be mentioned, since it proved to be of direct help to the mining companies which were engaged in winning the ore. This was the recognition that the folded sheets of manganese ore had generally a marked pitch, and that the direction of this pitch could be determined in a single exposure by observing the groovings developed on the bedding planes of the associated rocks. The recognition of this principle must have saved the companies many thousands of rupees, previously lost through

their inability to understand the probable underground course of the ore bodies.

The number of papers already published by Sir Lewis Fermor is well over 80. Of these one may be picked out as of particular scientific interest. As a result of studying the rocks of the Eastern Ghats, which are rich in garnet and of high density, it occurred to Sir Lewis to enquire into the reasons for rocks in certain areas being composed of minerals of high density, such as garnet, whereas elsewhere rocks of similar chemical composition are composed of minerals of lower density. This led him to suggest that below the plutonic zone of granites and gabbros there occurs an infra-plutonic shell of similar bulk composition but composed of denser minerals, of which the chief is garnet. This shell was regarded as being a cushion upon which the isostatic operations of the earth have their foundations; for it would only require a release of pressure over any given portion of the infra-plutonic shell to allow the liquefaction of that portion of the shell under the high temperatures present. In this way he was able to offer an explanation of many geological problems, such as isostasy, magmatic differentiation, the origin of earthquakes, and even the constitution of meteorites. It is unfortunate that this work, published so long ago as 1914, has not been followed up in greater detail. At the moment it is being revived in connection with the origin of earthquakes, and one Japanese seismologist has recently supported the hypothesis, following up R. D. Oldham's suggestion that earthquakes are due to the sudden transformation of rocks of the infra-plutonic zone into less dense forms in the manner indicated above, a change, which, being endothermic, may take place with explosive rapidity.

In 1911 a detailed survey of the Archæan rocks of the Central Provinces was begun, and Sir Lewis Fermor was placed in charge of the party. He at once initiated the mapping of these very old rocks in a more detailed manner than had ever before been attempted. This work has continued intermittently since that date, but it is unfortunate that owing to official administrative duties Sir Lewis has not yet had an opportunity of publishing his own results. We may perhaps express the hope that in the quieter times ahead opportunity may be found for bringing this valuable work to fruition.

During the War Sir Lewis Fermor rendered valuable service on deputation to the Railway Board, during which time he investigated the Bokaro coalfield, and the Karanpura and Talchir coalfields, while he also went on deputation to the Indian Munitions Board. The value of this work received recognition at the hands of the Government of India when, in 1919, he was made an O.B.E. For his contributions to theoretical geology he was awarded in 1921 the Bigsby Medal of the Geological Society of London, while in 1934 he was elected a Fellow of the Royal Society.

During his long service in India, Sir Lewis Fermor has been President of the Mining and Geological Institute of India, President of the Geology Section of the Indian Science Congress, General President of the Indian Science Congress, and now, at the time of his retirement, he is President of the Asiatic Society of Bengal, and President of the National Institute of Sciences of India, the oldest and the youngest academies of scientific learning in India. To each of these Institutions he has delivered inspiring and original addresses, which have indicated the wide scope of his outlook.

Sir Lewis Fermor was made Director of the Geological Survey in 1932. During his tenure of the Directorship it has been a great disappointment to him that his Department, for adventitious reasons, suffered so severely during the retrenchment carried out by the Government of India in 1931-32. His untiring advocacy of the value of the Geological Survey to the prosperity of India has, however, resulted in the partial restoration of the cadre of his Department. In the Birthday Honours of this year the honour of Knighthood was conferred upon him for his long and distinguished services to India, a reward, however, which he himself likes to regard as a recognition by the Government of India of the value of his Department to this country.

Great as have been Sir Lewis Fermor's achievements in the development of India's mineral resources and in the domain of pure science, it is probable that many will regard his unremitting endeavours last year to unite scientists in India, when there appeared the possibility of an undignified rupture, as his most happy achievement. The tact and patience which he displayed as Chairman of the Indian Science Congress Academy Committee revealed to many a new aspect of his character, which finally resulted in the formation of the National Institute of Sciences of India, inaugurated on January

7th, 1935, by H. E. Sir John Anderson, the Governor of Bengal, with Sir Lewis Fermor as the first President.

In bidding farewell to Sir Lewis Fermor, it would be ungracious to omit a reference to Lady Fermor. During the three years that she has been by his side in India, she has, by her charm and understanding, endeared herself to all who have had the good fortune to come in contact with her, and especially to every member of Sir Lewis Fermor's own Department. We hope that the years that are ahead of them may be rich in achievement and filled with prosperity and happiness.

Industrial Intelligence and Research in India.

By N. Brodie,

Director, Industrial Intelligence and Research Bureau.

THIS article deals with the formation and activities of the organisation recently set up by the Government of India to deal with industrial intelligence and research. The importance of industrial research under present-day conditions is universally recognised and Government bodies of one sort or another exist in all the major industrial countries but industrial intelligence is not so much in the foreground and, by laying some stress on this, India strikes out a new line. Nevertheless, although not given the same emphasis in other countries, industrial intelligence is generally, perhaps always, an important accompaniment of industrial research and most industrial research organisations have some arrangement for intelligence work, frequently in the form of a special department dealing with this work.

In India Industries is a transferred subject and therefore, so far as British India is concerned, a matter for the Provincial Governments. Most Provincial and many State Governments have instituted Departments of Industries, generally under the charge of an officer designated the Director of Industries. Several Departments of Industries, both in the Provinces and in the States, maintain industrial laboratories in which research work is carried out. For some time past it has been generally felt that the activities of these different laboratories suffer from lack of co-ordination and at the Fifth Industries Conference, held in July 1933, this question was raised in a specific form and it was recommended that "some central co-ordinating authority should be set up for the collection and dissemination of industrial intelligence, co-ordination of research and the organisation of industrial exhibitions". This recommendation was accepted by the Government of India and it was decided that a body of this type should be formed and attached to the Indian Stores Department, a Department which has much contact with industrial matters in India. The Chief Controller of Stores, Sir James Pitkeathly, drew up a scheme which was placed before and accepted by the Sixth Industries Conference held in July 1934 and subsequently sanctioned by the Government of India. This scheme will be found described in detail in bulletin of Indian Industries and Labour No. 52 giving the proceedings of the Sixth Industries Conference.

In accordance with Sir James Pitkeathly's proposals the Government of India sanctioned, with effect from the beginning of the present financial year, the formation of what is known as the *Industrial Intelligence and Research Bureau*. The staff of the Bureau consists of a Director, an Assistant Director and the necessary technical and clerical assistants. It is attached to the headquarters of the Indian Stores Department and is therefore located at New Delhi and Simla. At the same time a Research Branch was formed at the Government Test House, a laboratory situated at Alipore (Calcutta), which is also under the control of the Indian Stores Department. The staff of the Research Branch consists of a Research Officer, an Assistant Research Officer, 8 Chemical and Physical Assistants and clerical and menial staff.

The programme of the Research Branch and all important matters of policy involving the Bureau are brought before the Advisory Council for Industrial Intelligence and Research. This Council consists of the Directors of Industries or corresponding officers of the Provincial Governments and of seven Indian States, representatives of different Central Government Departments, four non-official members nominated by the Government of India and non-official

members nominated by each of the Provincial Governments. The Chairman is the Joint Secretary to the Government of India, Department of Industries and Labour and the Director of the Bureau acts as the Secretary. By the inclusion among the members of the Advisory Council of a considerable non-official element, it is hoped that the Council will be able to obtain the assistance of Industrialists and business men and hence keep in touch with the practical problems of industry.

The Advisory Council held its first meeting in Simla on July 8th and 9th, 1935. As a first step towards the co-ordination of the research activities of the different Provincial and State laboratories it was decided to form a Committee to deal with research in two subjects with one or other of which, as it happens, every such laboratory has, to some extent at least, interested itself. These are: (1) fatty oils and soap, and (2) essential oils. A second Committee was appointed to consider the question of the allocation of prizes for papers for which purpose a sum of Rs. 10,000 a year has been set aside. The programme of research for the Government Test House was considered in detail and various researches were agreed to. As a step towards forming a judgment of the problems of the glass industry in India it was recommended that the Bureau should undertake a survey of the glass factories in India and publish a review of the whole position. The important question of industrial standardisation was considered and it was recommended that specifications used by the local governments and the Railway and Indian Stores Department should be sent to the Bureau for examination. The object of this is to ensure that specifications are so framed as not to exclude materials made in India.

It will be seen that the organisation for industrial intelligence and research consists of three distinct but closely linked parts, *viz.*, the Advisory Council, the Bureau and the Research Branch of the Government Test House. The Advisory Council deals with broad questions of policy in all matters affecting the organisation as a whole. The present intention is that it should meet once a year and it has been proposed that it should meet at different important centres in rotation. Matters sufficiently important to be brought before the Council which cannot await the annual meeting are dealt with by correspondence. The Bureau acts as the secretarial body of the Advisory Council and implements its recommendations. On the research side it is responsible for drawing up detailed schemes of the projects accepted by the Council. On the intelligence side it deals with requests for industrial information forwarded by Directors of Industries. This is the normal channel through which enquiries are received. The Bureau is accumulating a library which it is hoped will be reasonably comprehensive as regards the matters with which it deals. The Research Branch of the Government Test House is concerned solely with carrying out research work on the lines laid down by the Bureau on the authority of the Advisory Council. The association with the existing organisation of the Government Test House will undoubtedly be of much value to the new branch, since the Government Test House is well equipped and its officers have considerable experience of industrial problems. The subjects for research chosen by the Council include:—

(1) The investigation of the behaviour of paints of different formulæ on exposure to atmospheric and other influences. A considerable amount of work has previously been carried out by the Government Test House on this subject.

(2) The investigation of the behaviour of vegetable oils when used for the lubrication of internal combustion engines. For this purpose the Government Test House will be equipped with a petrol engine of the motor car type together with the necessary cooling devices and other accessories and a dynamometer for measuring the energy output.

(3) The investigation of the behaviour of Indian cement when tested according to the methods proposed to be adopted for the new British Standards Specification and also the behaviour of Indian sands in these tests.

(4) The investigation of various problems affecting the use of lime as a building material.

(5) The investigation of the effect on the properties of dry cells of systematic variation of composition. For this purpose a constant temperature plant will be installed. A considerable amount of work has previously been done in India on dry cells, the manufacture of which appears to be a promising small industry, but a systematic investigation of the type proposed necessitates working at a fixed temperature.

Otherwise variations of performance arising from differences of composition are, unless they are very marked, obscured by the large temperature effect shown in the watt output of such cells.

(6) A systematic investigation of the different Indian sands and felspars which appear to be suitable for glass making. If use can be made of felspars found in India, one of the problems affecting the glass industry, *viz.*, the fact that it depends on imported soda, will not be solved but at any rate lessened. Various analyses of Indian sands are available but the Tariff Board in its recently published report expresses the opinion that the data were not sufficient. Less attention appears to have been paid to the possibly important question of the utilisation of felspars.

To provide for the expenses of the Bureau and the Research Branch of the Government Test House, the Government of India have sanctioned the expenditure of a sum of five lakhs of rupees spread over three years. The exact apportionment of this sum cannot at present be foreseen but probably, in very round figures, some three lakhs will be spent on the Bureau, including the award of prizes, and two lakhs on the Research Branch of the Government Test House.

The organisation described has not been in existence long enough for it to be possible to forecast with any confidence what its future is likely to be, but it is hoped that the brief account given will give an idea of the lines on which it is at present proposed to work.

Exploration of the Upper Atmosphere by means of Sound Waves.

By K. R. Ramanathan,

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THE maximum height which balloons carrying self-registering instruments have reached is about 35 km. A limit to the attainable height is set by the properties of the fabrics out of which balloons can be made. With improved fabrics it is possible that this height may be exceeded, but this is a problem for the future. An altogether different method for studying the physical conditions in the layers of the atmosphere which lie immediately above the reach of balloons is by the use of sound-waves. Beginning from 1904, when Van d. Borne discussed the propagation of sound-waves proceeding from an explosion of dynamite in Westphalia, the subject has developed considerably. During the second Polar Year, August 1932 to August 1933, a special series of explosions were arranged in Holland and also in the Polar regions. The results of this and other previous work are collected together in a special number of the *Zeitschrift für Geophysik* published last year. A lucid resumé of the present position of the subject and an account of the work done in England in the last decade is contained in the Symons Memorial Lecture delivered in March 1935 before the Royal Meteorological Society of London by Dr. F. J. W. Whipple, the Director of the Kew Observatory, and the foremost worker on the subject in Britain.

Some of the principal features of the propagation of sound from a loud explosion which can be inferred from aural observations can be summarised as below. Surrounding the source of sound, there is a region of 50–60 km. radius in which the intensity of the sound falls off gradually with distance; beyond 50–60 km. the sound is not audible. Going farther from the source, the sound again revives, often sharply, at a distance which may vary from 100 to 200 km. This second "zone" of audibility is often about 100 km. wide. If we calculate the velocity of the sound heard in this region from the distance from the source and the time between the explosion and the time of hearing the report, the computed velocity is found to be much smaller than the velocity corresponding to the temperature prevailing in the lower atmosphere. An explanation of these peculiarities was offered by Van d. Borne himself. In the immediate neighbourhood of the source the sound travels in the lower atmosphere, but that received in the second zone comes not directly, but by a longer path after reflection from the upper atmosphere. Timing the reception of the sound at known distances enables the determination of the delay in making the detour and the results of observations show that the sound gets reflected at heights ranging from 35 to 45 km. in the atmosphere.

Occasionally, the second zone of audibility is followed by yet a third one with a second zone of silence between. The sound received in this zone is due to waves reflected twice from the upper atmosphere and once from the ground.

The hearing of gun-fire at great distances from the battle-front during the European War in 1914–18 provided much interesting new information. It was found that during summer in Europe sounds travelled to great distances to the west, while during winter, they could be heard much farther in the east. The audibility at the same distance in different directions was not also the same. Further progress in the subject came with the organisation of pre-arranged explosions and the development of the technique for the reception of the sound. In the Continent of Europe, special explosions were made by the destruction of surplus munitions and in England advantage was taken of the firing of artillery guns. The receiving instruments used in Germany are based on the principle of magnifying optically the movements of a light piston or stretched membrane at the mouth of a resonator; in England, Tucker's hot-wire microphone is used. The arrival of waves is recorded at a number of places at distances going up to 300 or 400 km. from the source and advantage is taken of the broadcasting organisation to send wireless waves every second for time-marking purposes. An important quantity that is determined in recent work is the angle which the arriving wave makes with the horizontal: this gives the velocity of sound at the topmost part of the trajectory, being equal to $v \sec i$, where v is the velocity of sound near the ground and i the angle which the trajectory makes with the ground. The angle generally lies between 10° and 35°. Knowing the velocity of propagation at the topmost part of the trajectory and the distribution of temperature in the first 30 km., it is possible with certain simple assumptions to complete the trajectories of the sound in the upper atmosphere. The assumptions usually made are that up to a certain height, the velocity of sound in the stratosphere is constant and that above this it increases rapidly. In recent calculations, the influence of wind in the accessible layers of the atmosphere is also taken into account. The calculations show that the downward movement of sound begins at 35–45 km. The increased velocity in the upper atmosphere implies either an increase of temperature or a decrease of molecular weight. For various reasons, the former alternative is believed to be true in the layers under consideration.

The average distribution of temperature in the upper atmosphere over Europe in summer deduced from the collected results of these experiments is shown in Fig. 1.

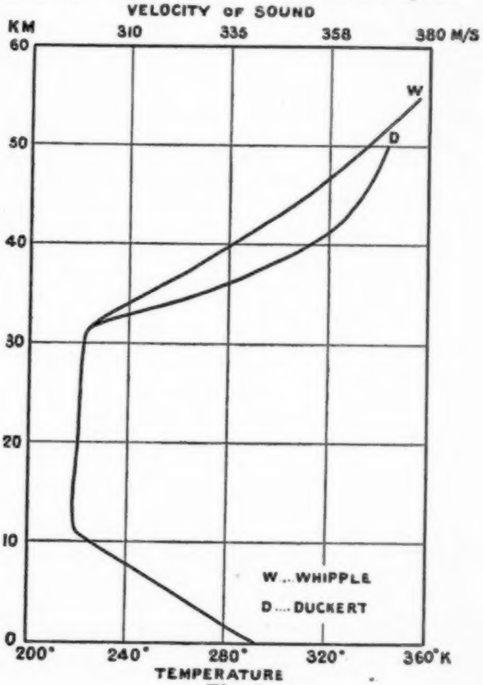

Fig. 1.

The marked difference between summer and winter as regards audibility at stations east and west of the source has already been mentioned. The records of self-registering instruments also show differences of times of travel of sound in different directions which can only be explained by large velocities of the order of 20–40 metres per second in the stratosphere, easterly in summer and westerly in winter. Many other facts such as the movement of persistent meteor trails and luminous night clouds support the same conclusion.

A reason for the strong westerly and easterly winds in winter and summer respectively in European latitudes has been put forward by Whipple. The results of sounding balloon ascents made at Abisko in Lapland during the years 1921 and 1929 showed a remarkable annual variation of

temperature in the stratosphere, the mean temperature at 18 km. changing from 235° A. in June and July to about 210° A. in November to February. This very large change of temperature causes a seasonal change of pressure gradient between the temperate and polar regions causing easterly winds in the stratosphere in summer and westerly winds in winter.

The rise of temperature above 35 km. in the temperate latitudes is generally attributed to the absorption of ultra-violet solar radiation by ozone in the region 2,900–2,200 A.U. Taking the distribution of ozone in the vertical as worked out by Dobson, Götz, and Meetham, and assuming that the main radiating substance in the stratosphere below 50 km. is water-vapour (in such quantities as we may reasonably expect to be present) and carbon dioxide, it is easy to explain the course of temperatures over Europe deduced from experiments on the propagation of sound from explosions. But the fact that even in Polar regions in winter where the atmosphere has not received solar radiation for weeks, the phenomenon of anomalous propagation of sound is observed shows that the above explanation is insufficient.

Observations of the anomalous propagation of sound in the tropical atmosphere are practically absent, the only known instance in low latitudes being those of an explosion of a train-load of gelignite in South Africa in July 1932, when the sound was heard at a distance of 500 km.

It is obvious that the detailed investigation of the propagation of sound to great distances in low latitudes cannot fail to yield results of fundamental importance to the Physics of the Atmosphere. If the sympathetic co-operation of the Indian Military Department can be secured, the problem does not appear to present serious difficulties. Side by side with this, the problem of the vertical distribution of ozone in our latitudes would also have to be investigated.

The Nature and Origin of Insect Colours.

By M. S. Mani.

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THE nature, origin and significance of the colours of insects have attracted the attention of workers from very early times. Within recent years, great advances have been made along various directions. In this note attention is directed to the recent advances in the subject, in so far as they relate to the nature and origin of insect colours.

The great varieties of colours and markings exhibited by insects naturally fall into two groups: (1) Structural colours, and (2) Pigmentary colours. Structural colours are due to light scattering, reflection, refraction and diffraction effects, as a result of certain peculiarities in the minute structure of the integument of insects and not to special pigments. The pigmentary colours, on the other hand, result from some definite chemical substance such as chlorophyll, melanin, etc. Some insects, as the metallic coloured beetles, owe their brilliant colours to structural peculiarities, while in others like the larvæ of some Lepidoptera, the colours are due to pigments. In most insects, however, combination colours are more prevalent than purely structural colours; pigments exist side by side with structural peculiarities which by themselves are also colour producing. This, for instance, is the case with *Ornithoptera poseidon* investigated by Onslow[1] who found that the green colour of this insect results from a combination of yellow pigment with a structural blue.

It is very difficult to elucidate the origin of structural colours of insects and the results of recent workers differ in several important respects. The white colour of insects is due to the absence of any special pigments and results from the minute structural details of the cuticle irregularly scattering the light waves by multiple reflection and refraction. All the white colours of insects are ultimately to be traced to this source, though it is believed that in a few insects the presence of uric acid in a finely divided state is the cause of white colour. It has, however, been shown that in such cases even after the removal of the uric acid by treatment with dilute alkalies, the white colour remains unchanged. That the white is due to structural peculiarities is

[1] Onslow, H., *Biochem. Journ.*, **1916**, **10**, 26.

further shown by the evidence obtained by the disappearance of the white when the air in contact with the white parts is replaced by a colourless liquid of nearly the same refractive index as the chitin of insects. The original white is fully restored when the liquid is removed and the chitinous part dried. The recent researches of Mason[2] further show that a colourless cuticle with an irregular reflecting surface is generally white.

The other structural colours of insects are of two types: (1) the iridescent or the so-called "metallic" colours, and (2) the non-iridescent or the non-metallic colours. The elytra of the metallic coloured beetles, the bodies of the enamelled Rose-chafers (*Cetoniids*) and the metallic Chalcids and the scales of certain brilliantly coloured Butterflies, etc., show marked iridescence. The non-iridescent colours are found only in the larvæ of some Lepidoptera.

Considerable attention has, within recent years, been devoted by such workers as Onslow, Suffert and Mason, to the investigation of the iridescent colours of insects and various causes have been regarded as responsible for them. It is now believed that the iridescent colours of insects are caused by:

(i) Diffraction effect due to the presence of a grooved surface or "grating".

(ii) Interference at surface due to simple or multiple films.

(iii) Tyndall effect or scattering of light waves by particles with diameters less than the wave-lengths of light.

(iv) Selective reflection of a narrow band of the spectrum from an opaque and highly reflecting surface.

According to Mason,[3] the brilliant iridescence of the elytra of the Lamellicorn beetle, *Sericea sericea*, is due to the diffraction effect produced by the fine striæ, about 20,000 per inch, running transverse to the length of the elytra. The iridescence of this beetle, owing to the grating being external, is transferable to collodion impressions. There are other insects recorded by Onslow[4] in which the iridescence is not transferable. This, for instance, is the case with the butterfly, *Morpho cypris*, whose scales are brilliantly iridescent. These instances, however, appear to be exceptions among insects and the general conclusions of Onslow,[4] Suffert[5] and Mason[3] are opposed to the view that diffraction plays an important part in insect colouration. Onslow has further observed instances where the collodion impressions of the gratings are brilliantly iridescent while the insects themselves are not.

Diffraction theory is entirely inadequate in the case of the non-pigmented wings of the Dragon flies, where no grating has yet been shown to exist. The view of most investigators in such cases is in favour of the interference theory. Mason's[3] work seems to show that the iridescence in this case is explainable on the basis of multiple thin films separated by a material of different refractive index, a phenomenon which was comprehensively dealt with by Rayleigh.[6] The recent preliminary studies of the writer indicate that the purplish iridescence of the wings of some species of the Chalcid genera *Leucospis* and *Dirhinus* is also due to interference. Scale iridescence is also explainable on the same lines. The result of swelling and compressing the scales and of permeating them with liquids of the same refractive indices seems to lend support to this view.

Mason[3] divides iridescent scales into three types: (1) *Urania* type, (2) *Morpho* type, and (3) *Entimus* type. In the first type of scales all the colour-producing films are parallel to the surface of the scale, overlaid by rib-like structures. The multiple films are either in the upper or the lower lamina of the scale. Suffert[5] demonstrated that in the second type of scales the reflecting films are situated in the rib-like structures themselves at an angle to the base of the scale, *i.e.*, inclined to it. The optical result of such a structure is a brilliant metallic blue. In the third the films are in the interior of the scales and inclined in different directions, so that corresponding colour patches are produced. This type is seen in various species of the Diamond beetles of the genus *Entimus*. Biedermann[7] and Mallock[8] explained the iridescence of these beetles wholly by the theory of thin films. Michelson,[9] on the other hand, held that stratified

[2] Mason, C. W., *Journ. Phys. Chem.*, 1926, **30**, 383.

[3] Mason, C. W., *Journ. Phys. Chem.*, 1927, **31**, A, 321; B, 1856.

[4] Onslow, H., *Phil. Trans. Roy. Soc.*, 1921, **B 211**, 1.

[5] Suffert, F., *Zeit. Morphol. Ökol. Tiere.*, 1924, **1**, 172.

[6] Rayleigh, Lord, *Proc. Roy. Soc.*, 1917, **A 93**, 565.

[7] Biedermann, W., *Handb. Vergleich. Physiol.*, 1914, **3**, (2 B), 1657-1994.

[8] Mallock, A., *Proc. Roy. Soc.*, 1911, **A 85**, 598.

[9] Michelson, A. A., *Phil. Mag.*, 1911, (6), **21**, 564.

films could not be responsible for the varied colour of scales, and supposed that the effect must be due to diffraction by an internal grating of the scale. He was, on theoretical grounds, able to calculate that the grating should comprise 5,000–10,000 striæ per centimetre and this agreed with actual counts. Onslow postulated that to satisfy this theory it was necessary to suppose that the gratings are of the saw-tooth type, as all the light is concentrated in one spectrum. He did not, however, accept diffraction as the sole cause but concluded that interference by thin films also must play a part in the production of iridescence. Mason,[3] on the other hand, agreed with the earlier workers in explaining iridescence on the basis of the stratified films alone.

Mason's[2] work also seems to show that the blue colour of certain insects, such as the Dragon flies, can be interpreted on the basis of Tyndall effect. According to this view the colour is due to the scattering of light by minute particles of a transparent substance immersed in a medium of a different refractive index to their own. When the size of particles is small as compared with the wave-lengths of light, the shorter waves are scattered, while the longer ones pass unhindered, and the scattered light is of a blue colour.

Experimenting with highly iridescent beetles, Onslow[4] concluded that in some beetles at least the surface film absorbs only a certain part of the spectrum, while the rest is strongly reflected. According to this view the iridescence of these beetles is a case of selective reflection. It is not, however, clear how such a film is formed and Mason[3] has discussed at length the weak points of this theory. According to him the colours of the metallic beetles and the enamelled Rose chafers result from multiple stratified films of considerable thickness lying on the integument. The colours are further supposed to be modified by the action of certain rod-like structures which are arranged in the cuticle perpendicular to the surface.

The main work on the pigmentary colours of insects is perhaps that of Poulton,[10] whose experiments with Lepidopterous larvæ are well known. Recent workers such as Przibram,[11] Glaser,[12] Palmer[13,14] Hungerford,[15] Wigglesworth,[16] Knight,[17] Thompson[18] and Brindley[19] have also contributed materially to our knowledge of the various pigments of the insects.

The pigments most commonly met with in insects are (1) chlorophyll and its derivatives, (2) hæmoglobin and allied pigments, (3) pigments of protein origin, and (4) pigments with purine bases. The spectroscopic investigations of Poulton indicated the presence of chlorophyll and its derivative xanthophyll in the blood and integuments of some caterpillars, such as the green larvæ of some moths. These pigments are absorbed with the food, and do not undergo any marked changes in the blood of the insect. Przibram[11] is opposed to Poulton's conclusions. He does not agree that spectroscopic evidence alone is sufficient to establish the presence of chlorophyll in insects and stresses the necessity of chemical tests. He proposes a new name "Tiergrun" for the green colour of animals. Gerould,[20] however, criticises Przibram's chemical tests as inconclusive and in general agrees with Poulton. In this connection the work of Gräfin von Linden[21] is of special interest; she found that the red and yellow pigments found in the wing scales of the butterflies of *Vanessa* spp. are derived from the chlorophyll absorbed during larval life. The red and yellow colours of Coccinellid and Chrysomelid beetles and the red colour of the Reduviid bug, *Perillus bioculatus*, have been shown by Palmer and Knight[14] to be due to the carotin derived from their food. They also demonstrated the presence of anthocyanin in the vermilion-coloured Aphid, *Tritogenaphis rudbeckiæ*; a similar conclusion was arrived at by Glaser[12] in regard to the red Aphid, *Pterocomma smithiæ*.

Hæmoglobin is of rare occurrence among insects and is only found in some larvæ

[10] Poulton, E. B., *Proc. Roy. Soc.*, **1873, B 504,** 417.

[11] Przibram, H., *Pfluger's Arch. Physiol.*, 1913, **153,** 385.

[12] Glaser, R. W., *Psyche.*, 1917, **24,** 30.

[13] Palmer, L. S., *Carotinoids and Related Pigments*, New York, 1922.

[14] Palmer, L. S., and Knight, H. H., *Journ. Biol. Chem.*, 1924, **59,** (A), 443; (B), 451.

[15] Hungerford, H. B., *Canad. Entomol.*, 1922, **54,** 262.

[16] Wigglesworth, V. B., *Proc. Roy. Soc.*, 1924, **B 96,** 149.

[17] Knight, H. H., *Ann. Entomol. Soc. America*, 1924, **17,** 258.

[18] Thompson, D. L., *Biochem. Journ.*, 1926, **20,** 73, 1026.

[19] Brindley, M. H., *Trans. Entomol. Soc. London*, 1929, **57,** 5.

[20] Gerould, J. H., *Journ. Exp. Zool.*, 1921, **34,** 385.

[21] Linden, Gräfin G. von, *Ann. Sc. Nat. Zool.*, 1905, **20,** 158.

of the Dipterous family Chironomidæ. It has recently been found by Hungerford[15] in the Notonectid, *Buenoa*.

The most important pigment of protein origin found in insects is melanin; it is commonly found in many groups. Of the pigments with purine bases, uric acid and its derivatives have been shown by Hopkins[22] to be the cause of white and yellow colour of wings of butterflies of the family Pieridæ.

[22] Hopkins, Sir F. G., *Phil. Trans. Roy. Soc.*, 1896, **B 186**, (2), 661.

The Mathematical Theory of a New Relativity.*

BY SIR SHAH MUHAMMAD SULAIMAN—A CRITICAL REVIEW.

§ 1. In the two papers published in the *Proceedings of the U. P. Academy of Sciences*, the author claims to have given a modification of Newtonian kinematics and Newtonian dynamics which not only yields all the results deducible from relativity but disproves the assumptions of relativity by deriving results more in accord with observation. He further derives some equations which, superficially, at any rate, look like generalisations of relativistic equations and then deduces Newton's forms as first approximations and Einstein's as higher ones. The first article consisting of Chapters 1 and 2 is devoted mainly to the theory of gravitation and the second article consisting of Chapters 3, 4 and 5 deals with Cosmology and questions of special relativity.

The first of these articles was included by Shapley[1] as "one of the high lights of Astronomy during 1934" in his remarks at the annual dinner of the American Association of Variable Star Observers on October 20, 1934.

It is not clear from Shapley's speech whether such a reference was based on a critical study of the article in question or on a tacit assumption, at its face value, of the claims put forward by the author. Quite recently this article has been critically reviewed by D. R. Hamilton,[2] who, confining himself to Sulaiman's explanation of the advance of perihelion, comes to conclusions which suggest that Sulaiman's work is absurdly erroneous. On the mathematical side not much notice has been taken of the work, the *Zentralblatt für Math.*,[3] satisfying itself with a bare mention of the article.

§ 2. Before undertaking a detailed review, a few general observations might be made. In the first place, it must be remarked that for the author to call his theory a new relativity is to give a completely false impression of his own work. If anything at all, the main thesis of the work is purely anti-relativistic and is vehemently opposed to a principle of relativity in any form whatsoever. Further one is struck by the large preponderance of books on popular expositions of relativity in the references to literature given at the end of the articles and this perhaps gives a clue to the great aversion to relativity which is manifest in the author's work. For, as is well known, the champions of the Theory of Relativity too often delight to bring forward those results of the theory which appear to them to be specially fitted to shock the common sense of people who take statements too literally and relativity is not the only example of a physical theory which appears absurd when its logical consequences are pushed to their very limit. In the list of references placed at the end of the second article it is curious to find the book "*Mysterious Universe*" ascribed to Eddington.

There are some mis-statements of facts in the author's references to relativity the most serious of which are in connection with the observational verifications of the general Theory of Relativity. The author says, (p. 4, Ch. 1), "It is now established that the supposed verifications are not exact," but the references to literature in support of this statement do not refer to the best observational data which are universally accepted. For the advance in the longitude of perihelion of Mercury the observational value is given as 40″·00 per century (the reference being to Eddington's *Mathematical Theory of Relativity*) whereas the best determinations are due to Chazy[4] and give 43″·5 as against the

* The Mathematical Theory of a New Relativity by Sir Shah Muhammad Sulaiman, *Proceedings of the U. P. Academy of Sciences*, 1934–35, Vol. IV, Part 2, pp. 1-36 and Vol. IV, Part 4, pp. 217–261.

[1] *Science*, 1934, **80**, 439.

[2] *Science*, 1935, **81**, 271–272.

[3] *Zentrablatt für Math.*, 1935, **10**, 88.

[4] *Comptes Rendus*, 1926, **182**, 1134.

theoretically predicted 42″·9. In the case of the gravitational deflection of light the author refers on p. 25, Ch. 1, to values obtained at several eclipse expeditions but significantly omits to mention the most satisfactory data available at present, *viz.*, those of Campbell and Trumpler,[5] who obtained the results 1″·72±0″·11 and 1″·82±0″·15 with two different sizes of cameras in the 1922 expedition of the Lick Observatory. As regards the gravitational shift of spectral lines a reference is made to the older work of St. John as quoted in Eddington's *Math. Theory* whereas in the cases of *both* the Sun and the dense companion to Sirius the agreement between the Theory of Relativity and observation is quite satisfactory as a result of the later work of St. John[6] and of Adams.[7] It appears therefore that the claims of Sulaiman's theory that it gives results more in accordance with observation than relativity are to be taken with some reservation. Other mis-statements of a minor nature are that relativistic invariance holds in vacuum only (p. 3, Ch. 1), that Einstein arbitrarily assumes $c+v=c$ and $c-v=c$ (p. 32, Ch. 2), that Milne's theory *ignores* gravitation and *evades* collisions (p. 224, Ch. 3) and that, in relativity, time is *wholly imaginary* and space *illusory* (p. 253, Ch. 5).

The mathematical part of the work is quite elementary and does not go beyond the solution of an ordinary differential equation of the second order. Looking from an æsthetic-mathematical point of view, one searches here in vain for such concepts like groups, tensors and generalised spaces characteristic of relativity or functional equations, sets of points, and Finsler spaces relevant to Milne's new relativity. On the other hand we have a set of drab differential equations as a series of approximations ninety per cent. of which is not relevant even to the author's own work. In dealing with the relativistic equation of a planetary orbit the exact solution of which can, as is well known, be expressed in terms of elliptic functions, the author claims to have devised a method superior to the methods of Forsyth, Morley and Pierpoint (p. 14, Ch. 1). A little scrutiny however shows that this superiority of method is achieved at the cost of a little wrong mathematics (*see* Section 9, p. 14, Ch. 1).

To obtain a solution of

$$\frac{d^2u}{d\theta^2}+u-\frac{3\mu}{D^2}u^2=\frac{\mu}{h^2}(1-2k\theta) \quad .. \ (2.1)$$

the author considers the solution of

$$\frac{d^2u}{d\theta^2}+u-\frac{3\mu}{D^2}u^2=0 \quad .. \quad .. \ (2.2)$$

which is correctly obtained as

$$u=\frac{D^2}{6\mu}+\wp\left\{\frac{\sqrt{\mu}}{D\sqrt{2}}(\beta-\theta)\right\}.$$

It is then stated that the solution of (2.1) is given by

$$u=\frac{\mu}{h^2}(1-2k\theta)+\frac{D^2}{6\mu}+$$
$$\wp\left\{\frac{\sqrt{\mu}}{D\sqrt{2}}(\beta-\theta)\right\} \quad .. \ (2.3)$$

presumably on the strength of the theorem that the general solution is the sum of the complementary function and a particular integral. It is, however, absurd to use this theorem here since it cannot apply to nonlinear differential equations like (2.1) and, moreover, $\mu(1-2k\theta)/h^2$ is not a particular integral.

As examples of the author's attitude towards scientific investigation we might mention his views (1) that Nature's limits are not fixed by our capacity to observe them (p. 230, Ch. 4), (2) that relative velocity cannot mean relative velocity as actually observed and we cannot go by measurements only (p. 242, Ch. 5), and (3) that a certain concept in relativity is unacceptable because the concept is philosophically an impossible one (p. 226, Ch. 3).

Finally on a point relating to a question of priority, it is highly amusing to see the author refer to a paper by P. Jordan mentioning gravitational quanta and claim priority by pointing out that his own theory was published in 1933 and again in 1934. It might be pointed out that, if it be a question of the "gravitons" of the Sulaiman type subject to the impulsive pulls and pushes of Newtonian dynamics, a whole literature[8] about them already exists. These "gravitons" have in fact a very close family resemblance to the "corpuscules ultramondains" of Le Sage,[9] the "radiating

[5] *Lick Observatory Bull.*, 1923, **11**, 41 and 1928, **13**, 130.
[6] *Astrophysical Journ.*, 1928, **67**, 195.
[7] *Proc. Nat. Acad.*, 1925, **11**, 382.

[8] J. Zenneck, Article on "Gravitation" in the *Ency. Math. Wiss.*, **Bd. V2**, §§30-33, 57-63.
[9] *Berlin Mém.*, 1782.

atomules" of O. Keller,[10] and the "residual attraction" of Crehore.[11] If, on the other hand, it be a question of gravitational quanta the possibility of whose existence is a consequence of the complementarity of the wave and corpuscular aspects of modern quantum mechanics, it is needless to say that such a concept is now quite well known for a number of years and finds a place even in elementary books on wave mechanics.[12]

§ 3. GENERAL RELATIVITY. (*a*) *Advance of Perihelion.*—The two main ideas which the author uses for dealing with gravitational phenomena are the finiteness of the velocity of propagation of gravitation and the introduction of a correction to Newton's law for the case of moving bodies. Both these ideas have no novelty in them going back in fact to the work of Laplace[13] and a series of later investigators.[14] Laplace himself did not assume any variations of Newton's law for moving bodies but only the finiteness of the velocity of propagation. He was thus led to apply a sort of an *aberration principle*, but his results were completely against all observed values in planetary perturbations. Assuming D the velocity of propagation of gravitation equal to c the velocity of light, his theory did not correctly give the advance of Mercury's perihelion and, in addition, gave a secular variation of the mean longitude contrary to observation. An attempt to bring down this secular variation to the observed value necessitated the assumption that $D = 500\,c$. It was later shown by Lehmann-Filhès[15] that such an attempt in the case of the perturbation of the moon's longitude required the assumption for D a value nearly a million times c.

Coming now to theories which assume both the finiteness of D and a modification of Newton's law we have the theories of Weber, Riemann, Gauss, Neumann, Clausius, Anding and Gerber. On the unsatisfactory nature of the first five theories reference may be made to the sources[16] mentioned above and we might confine our attention to the last two, specially to Gerber's theory which bears a great resemblance to Sulaiman's work. Anding[17] substituted for the Keplerian equations of motion the following equations

$$\frac{d^2x}{dt^2} + \frac{\mu x}{r^3} = \frac{\mu}{c}\cdot\frac{x}{r^3}\cdot\frac{dr}{dt};$$

$$\frac{d^2y}{dt^2} + \frac{\mu y}{r^3} = \frac{\mu}{c}\cdot\frac{y}{r^3}\cdot\frac{dr}{dt}$$

in order to explain the perihelion advance of Mercury, but these give rise, in addition, to a large perturbation in the eccentricity which is quite contrary to observation. Gerber[18] started with an expression for the potential in the form

$$P = k^2 m_1 m_2 : r\left[1 - \frac{1}{D}\,\frac{dr}{dt}\right]^a$$

and determined the constant a in order that the perihelion advance thus given may equal the observational value which he took 41″.25 per century (with $D = c$). He thus obtained two possible values of a, *viz.*, $a_1 = 2$ and $a_2 = -3$ and assumed the former value for his correction to Newton's law. It is remarkable that the other value $a_2 = -3$ gives Sulaiman's law if we observe that it is derivable from the above potential, remembering that Sulaiman's correction factor does not depend on r. The criticisms levelled against Gerber's theory therefore apply to Sulaiman's theory equally well and reference in this connection might be made to the remarks of Seeliger,[19] Laue[20] and Oppenheim.[21] Any one who has worked in the perturbation theory of celestial mechanics knows quite well that modifications of the Newtonian law introduced to explain a certain anomaly give rise to unforeseen perturbations in other elements of the planetary orbit. This is exactly what happens with Gerber's theory which, like the theory of Anding, gives unwanted perturbations in the eccentricity or alternatively an assumption that D is nearly $10^4 c$. We should therefore expect similar absurdities to arise in Sulaiman's theory and this has been confirmed by Hamilton who has shown that this theory gives an yearly increase of eccentricity equal to 0·0026

10 *Comptes Rendus*, 1908, **147,** 853–56.
11 *Electrical World*, 1912, **59,** 307–11.
12 See for *e.g.*, J. Frenkel, "Introduction to Wave Mechanics," who uses the word 'gravons'.
13 *Méc. cél.*, **4,** Livre. X, Chap. 7.
14 See (8) above, §§ 20 and 21–24. Also S. Oppenheim, Article on "Kritik des Newtonschen Gravitationsgesetzes," *Ency. Math. Wiss.*, **VI** 2, 22, § 31, 152–58; also F. Tisserand, *Méc. cél.*, **4,** Chapter 28.
15 *München, Ber.*, 1895, **25,** 371.
16 See references (8) and (14) above.
17 *Astr. Nachr.*, 1924, **220,** 353–60.
18 *Ann. d. Phys.*, 1917, **52,** 415.
19 *Ibid.*, **53,** 31 and **54,** 38.
20 *Ibid.*, **53,** 214. Also Article on "Relativitätstheorie" by W. Pauli in *Ency. Math. Wiss.*, **V,** 19, §58, 732.
21 *Ann. d. Phys.*, **53,** 163.

which means that Mercury goes off in a parabolic orbit within about three centuries! Alternatively an attempt to bring down this perturbation in eccentricity to Newcomb's value of $(-4\cdot3\pm2\cdot5\times10^{-8})$ per year requires the assumption $D=6\times10^4c$!

It would not be out of place to mention here other theories relating to the advance of Mercury's perihelion. We have Asaph Hall's[22] alteration of the law of Newtonian attraction from r^{-2} to $r^{-(2+\delta)}$ which gives the required perihelion advance if δ be put equal to $0\cdot00000016$ but, apart from its arbitrary nature, it gives a movement of 135″ in the apse of the Moon which is negatived by observation. Again the assumption of the oblateness of the Sun[23] explains the perihelion advance but gives very large perturbations of the inclination of Mercury's orbit. Finally the zodiacal theory of light[24] also gives rise to unwanted perturbations. One is therefore led, almost by a process of exhaustion, to Einstein's theory which by its very nature does not give any perturbations.

(*b*) *Gravitational Deflection of Light.*—The author's derivation for the deflection of light of a value equal to 4/3 times the Einstein value can only be described as truly amazing! He states (Ch. 1, p. 4) that Gerber's equation does not yield the value for the deflection which is certainly true and the same should also be true of Sulaiman's equations if properly handled. His method consists in taking the equation

$$\frac{d^2u}{d\theta^2}+u=\frac{\mu}{h^2}+\frac{3\mu}{D^2}u^2\ (D=c)\quad ..\ (3\cdot1)$$

as the differential equation of the path of a light particle in a gravitational field. This equation is the relativity equation for the path of a material particle and in Sulaiman's theory it is only an approximate equation (*viz.*, the third approximation) there being approximations of four higher orders. The general equations of Sulaiman's theory are obtained by treating v (velocity of the particle) as small compared with D and consequently neglecting higher powers of $\left(\frac{1}{D}\frac{rd\theta}{dt}\right)$ than the first. It is therefore obvious that when one is dealing with the motion of a particle whose velocity is D itself (*i.e.*, a light particle, since D is taken equal to c), it is wrong to start with an approximate equation. The author himself sees the need of this when he is dealing with the motion of an electron in connection with his explanation of the fine structure of spectral lines (Ch. 5, p. 258). The straightforward thing to do in this case is to write down the equations of motion *ab initio* using the relation $v=D$ and when this is done with the equations in Sec. 5, Ch. 1, p. 9, we easily obtain the equation to the path of the light particle

$$\frac{d^2u}{d\theta^2}+u=0\ ..\qquad ..\qquad ..\ (3\cdot2)$$

that is, a straight line showing that there is no deflection for a light particle in a gravitational field! This could also be *qualitatively* verified from Sulaiman's law of attraction, *viz.*,

$$-\frac{\mu}{r^2}(1-v/D)^3 \text{ by putting } v=D$$

and is in consonance with what Gerber's equations can give for the deflection. Thus while on the old pure Newtonian theory we could deduce a deflection at least equal to half the Einstein value, this generalisation by Sulaiman yields no deflection at all!

Assuming for a moment that (3.1) correctly gives the path of a light particle, the author still fails to justify his final result, for when he states (Ch. 2, p. 25) that $r\frac{d\theta}{dt}$ can never exceed the *tangential velocity* c, he assumes unconsciously that the tangential velocity is constant, but this cannot certainly be true. Even in the derivation of the deflection on Newtonian mechanics c is assumed to be the velocity at infinity of the light particle. The assumption of a constant tangential velocity is equivalent to taking the central orbit as circular and it becomes meaningless to talk of the deflection as the angle between the asymptotes of the orbit. Such circular orbits[25] are also possible for light particles according to general relativity but they are excluded[26] for purposes of obtaining the deflection.

There is a third mistake in this derivation of the deflection. By showing that the least value of the expression on the right hand side of (3.1) is $\frac{4\mu}{D^2}u^2\ (D=c)$ the conclusion

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22 *Astr. Journal*, **14**, 45.

23 See A. C. D. Crommelin, *Nature*, 1920–21, **106**, 788.

24 See H. Jeffrey's *M.N.R.A.S.*, **80**, 138.

25 D. Hilbert, *Gott. Nachr.*, **1917**, 73–75.

26 Laue, "Relativitätstheorie," **Bd. 2**, §24, 224–27.

is drawn that the deflection *is* exactly 4/3 times the Einstein value, but the correct conclusion to draw is that it *is at least* 4/3 that value. In a case like this where observational verification is essential one would naturally enquire what would be the *maximum* deflection possible, but the work is silent on this point!

(c) *Shift of Spectral Lines.*—No remarks appear to be necessary in this case for, according to the author's own showing, the "corrections provided by the 'New Relativity' are not appreciably large and the value of the ratio is the same as Einstein's" for spectral lines in the solar spectrum. For planetary spectra he remarks, "Unfortunately the ratios for the planets are too small as compared to that of the Sun and the more accurate formulæ cannot give any better results at present."

Having examined the achievements of this 'New Relativity' in the three crucial tests, we can well conclude by saying that no one would seriously think of adopting it as an alternative to the general theory of relativity for the explanation of gravitational phenomena.

§ 4. SPECIAL RELATIVITY. (*a*) *Relative Velocity.*—The author enunciates his 'first universal principle' as follows (Ch.5, p. 247):

The relative velocity v between two bodies moving with velocities u and v', measured by employing a messenger travelling with a velocity D in a to-and-fro journey, is given by the formula

$$\frac{v}{v'-u} = \frac{D(D+v'-u)}{(D+v')\,(D-u)} \quad .. \ (4.1)$$

and claims that this formula is more general than the corresponding formula of special relativity

$$v = \frac{v'-u}{1-\dfrac{v'u}{c^2}} \quad .. \quad .. \quad .. \ (4.2)$$

by showing that (4.2) is an approximation obtained from (4.1) by neglecting terms like $(v'^2u - v'u^2)/D^3$, etc.

It is difficult to see how a correspondence could be established between (4.1) and (4.2) if it be noted that in the derivation of (4.1) the notions of absolute space and absolute time are retained while these are foreign to relativity. (4.1) applies even to the case where u and v' are velocities relative to an observer who is at rest in his own system, while in such a case both classical and relativistic kinematics give $v'-u$ for the relative velocity. As an example of confused thinking it is hard to find anywhere in relativistic literature a parallel to the author's derivation of equation (4.1). An absolute distance between two moving points is assumed as r independent of all measurement and on this are made to depend a real and an apparent distance. This leads on to the notions of absolutely real relative velocities, apparently real relative velocities and really apparent relative velocities! Let us however assume that (4.1) actually corresponds to the relativistic equation (4.2). We can then deduce some absurd consequences.

(i) Putting $v'=D=c$ in (4.1) we deduce $v=c-u/2$ while classical kinematics gives $v=c-u$ and relativity gives $v=c$. We can therefore describe the Sulaiman kinematics as a sort of a hybrid form or as a sort of a semi-emission theory similar to the emission theory of Ritz.[27] Sulaiman's kinematics founders therefore on the rock of de Sitter's binary star test[28] as all other emission theories do.

(ii) Formula (4.1) looks superficially like a generalisation of Einstein's formula for addition of velocities and the author applies it to derive Fresnel's formula for the dragging coefficient and claims to have obtained a better approximation than the usual expression

$$c'_1 = c_1 - u\left(1 - \frac{1}{\mu^2}\right) \quad .. \quad .. \ (4.3)$$

where c'_1 is the velocity of light in moving water, $c_1=c/\mu$ the velocity in stationary water and u the velocity of the water. The corresponding expression deduced from (4.1) reads

$$c'_1 = \frac{\left(c_1-u\right)\left(1+\dfrac{c_1}{c}-\dfrac{u}{c}\right)}{\left(1+\dfrac{c_1}{c}\right)\left(1-\dfrac{u}{c}\right)} \quad .. \ (4.4)$$

The actual reduction of (4.4) to an equation of the same form as (4.3) (which the author has not carried out) gives after a slight simplification

$$c'_1 = c_1 - u\left[1 - \frac{1}{\mu(\mu+1)}\right] \quad .. \ (4.5)$$

In the case of water (4.3) gives for the second term on its right hand side the value of $0 \cdot 44\, u$ which has been well confirmed by the

[27] *Ann. de. Chim. et Phys.*, 1908, **13**, 145.

[28] *Proc. Amsterdam Acad.*, 1913, **15**, 1297 and 1913, **16**, 395.

experiments of Fizeau[29] and the later very accurate researches of Zeeman.[30] On the other hand formula (4.5) gives in the same case the absurdly high value of $0 \cdot 68\, u$ which is contrary to all observational results.

We can therefore safely dismiss as idle speculation all the results derived on the basis of this 'universal principle' and in particular the ridiculous analogues to Lorentz transformations on pp. 247-48, Ch. 5, between two moving systems which have a common time $t=t'$!

(*b*) *The Principle of Aberration* (Ch. 5, p. 251).—This principle which follows as a consequence of the finiteness of the velocity of propagation of a force has been mentioned already in connection with Laplace's theory of gravitation and is made extensive use of by the author who takes it as his second universal principle. According to him it is merely the necessary result of the compounding of two dynamical velocities, but it is difficult to see any justification for the reduction in the intensity of force along its apparent direction. It really makes no sense to say that when the velocity of flow is D, the effective *component of force* observed along the apparent direction *is D cos a.* There is an utter confusion here between velocity and force. This confusion is also responsible for the meaningless phrase "*the velocity of light* ON *a body moving with velocity v*". The claim of universality of application of this principle is belied by assuming that in the case of light the velocity is reduced while in other cases the intensity of force is changed (for example H in the explanation of Bucherer's experiment). There is yet another inconsistency in the application of this aberration principle to the case of "gravitons". The universality claimed would certainly require the modification in Newton's law of attraction to be $-\frac{\mu}{r^2} : \left(1+\frac{v^2}{D^2}\right)^{\frac{1}{2}}$ leading on to Gerber's equations, but the author uses, instead, the factor $\left(1-\frac{v}{D}\right)^3$ deduced from special consideration of 'graviton' pulls.

In his explanation of Minkowski's equation and of the possibility of velocities exceeding that of light the equations made use of are

$$\left.\begin{aligned} c_1 &= c \cos a \\ \tan a &= v/c \end{aligned}\right\} \qquad \cdots \qquad \cdots (4 \cdot 6)$$

where c_1 the apparent velocity of light has its direction perpendicular to that of v and a is the angle of aberration. If, as the author states, the principle of aberration is merely the result of compounding dynamical velocities it is impossible to see how both the equations in (4.6) could be simultaneously true. It is on the basis of such 'flawless' mathematics that the possibility of velocities up to ∞ is deduced and one might well suggest to the author the derivation of his first universal principle when one of the bodies is moving with such a velocity, for example a velocity greater than that of the messenger employed.

(*c*) *Michelson and Morley Experiment.*—The explanation offered is briefly as follows:—
Time of longitudinal journey

$$= \frac{l}{c+v} + \frac{l}{c-v}$$

$$= \frac{2lc}{c^2-v^2} \qquad \cdots \qquad \cdots \qquad \cdots (4 \cdot 7)$$

Time of transverse journey

$$= \frac{2l}{\sqrt{c_1^2-v^2}} \qquad \cdots \qquad \cdots \qquad \cdots (4 \cdot 8)$$

where c_1 is the same quantity as in (4.6).

Hence the difference in times

$$= \frac{2lc}{c^2-v^2} - \frac{2l}{\sqrt{c_1^2-v^2}}$$

$$= \frac{2lc}{c^2-v^2} - \frac{2l}{\sqrt{c^2-2v^2}} \text{ using } (4 \cdot 6)$$

$$= -\frac{l}{c}\left(\frac{v}{c}\right)^4 \text{ nearly,}$$

which cannot be detected by experiment.

By using the author's own 'universal principles' it can easily be shown that this explanation is untenable. For, according to the first universal principle of relative velocities, (4.7) should be replaced by

$$\frac{l}{c-v/2} + \frac{l}{c+v/2} = \frac{2lc}{c^2-v^2/4} \qquad \cdots (4 \cdot 9)$$

Again (4.8) is obtained by a wrong application of the second universal principle according to which the effect of a finite velocity of flow is the same *as if the body were stationary* and the direction of flow were shifted forward by an angle a and the velocity changed from c to c_1. It is therefore wrong to again compound c_1 with v and hence (4.8) should be replaced by

$$\frac{2l}{c_1} = \frac{2l}{\sqrt{c^2-v^2}} \qquad \cdots \qquad \cdots (4 \cdot 10)$$

Hence the difference in times

$$= \frac{2lc}{c^2-v^2/4} - \frac{2l}{\sqrt{c^2-v^2}} = -\frac{l}{c} \cdot \frac{v^2}{2c^2}$$

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[29] *Comptes Rendus*, **1851**, **33**, **349**.

[30] *Amsterdam Proceedings*, **1914**, **23**, **245**; **1915**, **24**, **18**.

which can certainly be measured but is contradicted by the null result of the Michelson-Morley experiment.

(*d*) *Fine Structure of Spectral Lines.*—The author has not derived the formula for fine structure on the basis of his own theory but only talked about in a certain hazy way which tends to suggest that he is unaware of the methods of even the old Bohr-quantum theory. One would naturally start with the proper expression for the Hamiltonian, then set up the Hamilton-Jacobi equation and introduce the angle and action variables, the quantum conditions being derived by equating the non-degenerate action variables to integral multiples of Planck's constant. Nothing of the sort is done here and it is suggested that the same equations of Newtonian form as used for planetary orbits should be employed with the retention of the term $\left(\frac{1}{D}\,\frac{rd\theta}{dt}\right)^2$ and the reader is left to proceed as best as he can with the help of the third universal principle which deals with the force acting on a spinning spherical shell. It is really a complete mystery what this universal principle has got to do with the motion of an electron in a central field of force and where this spinning spherical shell comes into the picture. In the absence of any quantitative results, it is impossible to attach any weight to the author's explanations.

§ 5. COSMOLOGY. We may well spare the author the joy of his profound cosmological speculations and trenchant criticism of other cosmological theories and proceed to examine those positive results of his theory which are expressed in a mathematical form. The only such result is the derivation of Hubble's famous velocity-distance law on the basis of the author's emission theory of matter and the conclusion therefrom that not only velocities of recession of nebulæ but also velocities of approach are possible. The fundamental equation is

$$\frac{d^2R}{dt^2} = \gamma \frac{dR}{dt} \quad \ldots \quad \ldots \quad \ldots (5\cdot1)$$

where R may be measured in any direction and from any origin and $\gamma = \frac{n\mu}{3}$, n being the number of gravitons emitted from unit mass per unit time and μ the mass of each graviton. From (5.1) we obtain by integration

$$\frac{dR}{dt} = \gamma R + A_0 \quad \ldots \quad \ldots (5\cdot2)$$

which is the expression for the velocity-distance law. From (5.1) also follows a cosmological principle that the relation of acceleration and velocity presents the same picture to all observers. It might be observed, in passing, that this cosmological principle can be considered as a particular form of Milne's principle of equivalent observers. On the basis of (5.2) it is claimed that velocities of recession and approach are both possible.

It might be remarked in the first place that the deep-lying velocity-distance proportionality could be very simply deduced[31] from pure classical *kinematic* considerations only on the basis of a cosmological principle of equivalent observers of the type derived by the author himself. Even in relativistic cosmology it is a simple deduction[32] from the form of the metric assumed in non-static models of the Universe. It appears therefore that it is quite redundant for the purposes of deriving Hubble's law to invoke the aid of an emission theory of matter which calls to aid supernatural agencies for the production of gravitons by the explosion of a sub-atomic shell.

It is again wrong to say that (5.2) explains both recession and approach. For, since R can be measured in any direction and from any origin, a simple change or origin reduces (5.2) to the equivalent form

$$\frac{dR}{dt} = \gamma R \quad \ldots \quad \ldots \quad \ldots (5\cdot3)$$

and γ, by its very definition, is a *positive* quantity unless one were to indulge in Schuster's[33] "holiday dreams" of negative masses. Thus (5.3) shows that $\frac{dR}{dt}$ has always the same sign as R, *i.e.*, the velocity is one of recession. All the enchanting speculation about approaching and receding nebulæ and a stable Universe are therefore seen to be without a foundation. Finally the author's criticism of relativistic cosmology loses much of its force if it be observed that he confines himself to the de Sitter static model whereas the trend of modern work[34] is in the direction of considering non-static models as better suited to explain observed facts.

B. S. M.

Received 20th August, 1935.

[31] E. A. Milne, *Relativity, Gravitation and World Structure*, 1935, §§ 71–72, 73–74.

[32] R. C. Tolman, *Relativity, Thermodynamics and Cosmology*, 456.

[33] *Nature*, 1898, **58**, 367 and 618.

[34] Tolman, *ibid.*, Chap. X, Part IV, 445.

The Particle Problem in the General Theory of Relativity.

IN a recent paper published in the *Physical Review* (Vol. **48**, 73), A. Einstein and N. Rosen have called attention to a possibility of accounting for atomic phenomena by the method of general relativity. Their essential idea consists in removing the singularities of the solutions of the field equations by a simple modification.

One will then have to treat physical space as consisting of two congruent sheets, the particle (neutral or electrical) being interpreted as a portion of space connecting the two sheets, *i.e.*, as a kind of bridge. The determinant of the components of the metric tensor vanishes at the surface of contact of the two sheets. Next, they recognise in the postulate of relativity which states that the motion of a particle takes place along a geodesic, a defect that the field and motion have been separated out. Einstein and Rosen regard that the concepts of particle and motion have to be treated as a part of the field itself. If there are several particles present, one should find a solution free from singularities of the space consisting of two sheets connected by many bridges if he adopts the above point of view. However, one cannot say whether regular solutions with more than one bridge exist at all.

The new field equations adopted by Einstein and Rosen are

$$g^2 R_{kl} = 0$$

instead of the old equations. This adoption would remove the singularities caused in the field equations by the vanishing of the g factors in the denominators of R_{kl}. The regular solution for the spherically symmetric static case is now

$$ds^2 = -4(u^2+2m)du^2 - (u^2+2m)^2(d\theta^2+\sin^2\theta d\phi^2) + \frac{u^2}{u^2+2m}dt^2$$

$$u^2 = r - 2m$$

instead of the Schwarzschild solution,

$$ds^2 = -\frac{1}{1-2m/r}dr^2 - r^2(d\theta^2+\sin^2\theta d\phi^2) + (1-2m/r)dt^2$$

which has a singularity for g_{11} when $r=2m$. In the new solution g vanishes when $u=0$, as g_{44} vanishes. The space can now be regarded as made up of two equivalent sheets corresponding to $u>0$ and $u<0$ joined by a plane $u=0$ or $r=2m$. Einstein and Rosen conceive of a bridge-like connection between the two sheets. They interpret it as a mathematical representation of an elementary, electrically neutral particle. This representation accounts for the non-existence of an elementary particle with negative mass, for one cannot regularise the Schwarzschild solution if it is so.

Just as in the above case of pure gravitational field, Einstein and Rosen have modified the field equations when both gravitation and electricity are present by multiplying the field equations by the factor g^2 and changing the sign of T_{ik}. They find the regular solution for a static spherically symmetric case with an electrostatic field as

$$ds^2 = -du^2 - (u^2+\epsilon^2/2)(d\theta^2+\sin^2\theta d\phi^2) + [2u^2/(2u^2+\epsilon^2)]dt^2$$

$$u^2 = r^2 - \epsilon^2/2$$

taking $m=0$. Einstein and Rosen believe that the massless solutions are the physically important ones to interpret an elementary electrical particle. One can see that the above solution is free from singularities and that the space is divided into two congruent sheets and that the charge is represented by a bridge between the two sheets. According to this, the most elementary electrical particle has no gravitating mass.

In the conclusion, they say, "Nevertheless one should not exclude *a priori* the possibility that the theory may contain the quantum phenomena. Thus it might turn out that only such regular many-bridge solutions can exist for which the 'charges' of the electrical bridges are numerically equal to one another and only two different 'masses' occur for the mass bridges, and for which the stationary 'motions' are subject to restrictions like those which we encounter in the quantum theory. In any case here is a possibility for a general relativistic theory of matter which is logically completely satisfying and which contains no new hypothetical elements."

N. S. N.

Letters to the Editor.

CONTENTS.

Diamagnetism of the Trivalent Bismuth Ion.

THE diamagnetic susceptibilities of a number of ions have been calculated by Pauling,[1] Stoner,[2] Slater[3] and Angus.[4] These theoretical considerations have enhanced the interest in the experimental determinations of ionic susceptibilities.

We have determined the diamagnetic susceptibilities of a number of trivalent bismuth salts by the aid of the Bhatnagar-Mathur Magnetic Interference Balance.[5] The value for χ_A for Bi^{+3} has been calculated by subtracting the value of the susceptibility of the negative ion from the experimentally determined value of the molecular susceptibilities of the salts.

Most of the values of χ_A for the negative ions have been taken from Kido's careful investigations.[6] For Cl′, the value 19·8 as experimentally determined in this laboratory[7] has been used. The χ values for $(PO_4)'''$, O″, and S″ have been taken from the International Critical Tables; the value of $(CrO_4)''$ has been calculated from that of H_2CrO_4 and the value for the citrate ion has been calculated from the values of χ for carbon, hydrogen and oxygen atoms as given in the International Critical Tables.

The results obtained are shown in the table below.

Salt	$-\chi_a \times 10^6$	$-\chi_m \times 10^6$	$-\chi_A \times 10^6$ for Bi^{+3}
Bismuth oxide Bi_2O_3	0·170	79·22	42·20
Bismuth hydroxide $Bi(OH)_3$	0·253	65·78	40·28
Bismuth trichloride $BiCl_3$	0·316	99·65	40·10
Bismuth tribromide $BiBr_3$	0·328	146·94	42·84
Bismuth triiodide BiI_3	0·340	200·53	40·93
Bismuth sulphide Bi_2S_3	0·240	123·40	38·45
Bismuth phosphate $BiPO_4$	0·254	77·22	41·72
Bismuth sulphate $Bi_2(SO_4)_3$	0·282	199·14	41·07
Bismuth chromate $Bi_2(CrO_4)_3$	—0·202	—154·33	43·45
Bismuth citrate $BiC_6H_5O_7$	0·302	120·20	41·38

The value of χ for Bi^{+5} has been calculated by Angus. The value for Bi^{+3} which is the commonest bismuth ion does not seem to have been calculated by either the Slater or the Angus method. In view of the experimental data available, we have calculated

the theoretical value of χ for Bi^{+3} by the Slater method, as a comparison of the theoretical and the experimental values should be of considerable interest.

The gram atomic susceptibility χ_A is given by the expression :

$$\chi_A = -\frac{e^2 L}{6mc^2} \Sigma_N r^{-2} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

According to Slater, the values of r^{-2} are given by

$$r^{-2} = \frac{(n')^2(n'+\frac{1}{2})(n'+1)}{(z-s)^2} \quad \ldots \quad \ldots \quad (2)$$

The values of χ_A can therefore be obtained according to equation (1) by summing over all the electrons remembering that r^{-2} in (2) is given as a multiple of a_0^2 where a_0 is the radius of the innermost orbit in hydrogen ($a_0 = \cdot 528 \times 10^{-8}$). This gives

$$-\chi_A \times 10^6 = 0\cdot 790\, \Sigma \frac{(n'^2)(n'+\frac{1}{2})(n'+1)}{(z-s)^2} \quad (3)$$

Calculating the values of r^{-2} for different electronic groups in Bi^{+3} and summing up, the value of Σr^{-2} is found to be $55\cdot 448$. Substituting this value in (3) the atomic diamagnetic susceptibility of Bi^{+3} comes to be $43\cdot 8 \times 10^{-6}$.

The value of χ_A for Bi^{+3} has been experimentally found to be $41\cdot 24$ and is in close agreement with the theoretical value $43\cdot 8$ calculated according to Slater's method. Angus has introduced a slight modification in Slater's formula for evaluating the effective nuclear charge. This modification has the effect of lowering the calculated value for susceptibility and would bring it in closer agreement with the experimental value.

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September 4, 1935.

[1] Pauling, *Proc. Roy. Soc.*, 1927, **A 114,** 181.
[2] Stoner, *Proc. Leeds Phil. Soc.*, 1929, **1,** 484.
[3] Slater, *Phys. Rev.*, 1930, **36,** 57.
[4] Angus, *Proc. Roy. Soc.*, 1932, **A 136,** 569-578.
[5] Bhatnagar and Mathur, *Phil. Mag.*, 1929, **8,** 1041.
[6] Kido, *Science Reports of the Tohoku Imperial University*, Series I, Vol. XXI, No. I.
[7] *Cf Phil. Mag.*, 1934, **18,** 449.

The Emission of Fast Particles.

As a result of a series of experiments recently carried out by Rutherford and others,[1,2] it has been shown that from a number of radioactive elements groups of fast particles are often emitted. Moreover the elements which are supposed to emit particles of given velocity really give out particles of velocities varying over a small range. Accordingly the wavestatistical formula deduced before[3] must be modified.

From a numerical computation of the energy of the disintegrated α-particles, it can be shown that they become free at least at a distance $10^{-13} \rightarrow 10^{-12}$ cm., from the centre of the core. On the other hand the wavestatistical formula of the radius of the hard core gives $r_0 \sim 10^{-15}$ cm., for radioactive substances. So we have to suppose that the region between 10^{-15} and 10^{-13} cm. is filled with electrically neutral particles. Evidently it corresponds to the neutral shell of Rutherford. Since it is outside the charged core, the electrical force of repulsion is Coulombian in this region.

According to Rutherford the shell is filled with polarised helium atoms. But it appears a more general assumption would be to suppose that the shell is packed with large numbers of α- and β-particles, such that the net charge is zero. The particles may possibly circulate in a number of orbits under a polarisation field. Thus the neutral shell may be supposed to consist of a number of thin shells of particles. Now as soon as an α-particle comes out of the core and passes through the shell, it will naturally interact with the circulating α-particles in the thin shells. And as a result of that an α-particle which was originally present in the shell is ejected.

It is evident that the rate of disintegration is really the rate of ejection from the thin shells. The previous wavestatistical formula gives the rate at which the α-particles enter the shell from the hard core within. Multiplying this rate by the number of α-particles present in an excited state in a given thin shell, we find for the disintegration constant:

$$\lambda = \text{const.}\ \frac{\sqrt{U_0 E}}{\text{Cot}\, u_0}.\ e^{-2k(2u_0 - \sin 2u_0)}$$

$$\sin^2 \frac{2\pi m v r_1}{h}$$

where the symbols have been explained in the previous paper.[4,5]

If it is supposed that the α-particles belonging to a particular group are all emitted with the mean velocity, then the factor $\sin^2 \frac{2\pi m v_1}{r_1}$ becomes evidently unity,

and the above reduces to the older wave-statistical formula.

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Calcutta,
August 26, 1935.

[1] Rutherford, Ward and Lewis, *Proc. Roy. Soc.*, **1931**, **131**, 684.
[2] Rutherford, Wynn-Williams and Lewis, *Proc. Roy. Soc.*, 1931, **133**, 351.
[3] K. C. Kar and A. Ganguli, *Phil. Mag.*, **1933**, **16**, 1097.
[4] Kar and Ganguli *loc. cit.*
[5] Kar and Ganguli, *Curr. Sci.*, **1934**, **2**, 387.

Rolf's Graphs to Sommerfeld's Attenuation Formula.

NORTON[1] has recently pointed out an error in Rolf's[2] calculations of flat-ground attenuation of wireless waves according to Sommerfeld's theory.[3] Since Rolf's graphs have been extensively employed in connection with experimental investigations on ground-attenuation, it is necessary to test how far this error would vitiate the attenuation curves drawn by Rolf.

Setting right the error, Norton has given the following empirical formula for the attenuation factor S for small values of b:

$$S = f(p_0) - \sin b \frac{\sqrt{p_0}}{2} e^{-\frac{5}{8}p_0}$$

where p_0 is Sommerfeld's "numerical distance" and is equal to $q/2$ of Rolf. The quantities b and q are defined by

$$\tan b = \frac{\epsilon + 1}{6\lambda\sigma} \cdot 10^{-15} \text{ and } q = \frac{2\pi \sin b}{(\epsilon+1)\lambda} \cdot r$$

where σ (expressed in e.m.u.) is the electrical conductivity, ϵ (expressed in e.s.u.) the dielectric constant of the ground, λ the wavelength (in km.) and r the actual distance in km. from the transmitter. The first term $f(p_0)$ in Norton's expression for the attenuation factor can be calculated from Van der Pol's empirical formula:

$$S = f(p_0) = \frac{2 + \cdot 3p_0}{2 + p_0 + \cdot 6p_0^2}$$

(This formula is free from the error pointed out by Norton.)

In Table I we have compared the values of attenuation factor for different values of q obtained from Rolf for (1) $b = 5°$ and (2) $b = 0°$ with those calculated from Norton's formula. The values of attenuation according to Van der Pol are also given in the table.

TABLE I.

b	q	Attenuation Factor		
		Rolf	Pol	Norton
5°	3·0	·59	·50	·47
	2·0	·70	·64	·61
	1·0	·85	·81	·78
	0·2	·97	·95	·93
0°	3·1	·5	·49	·49
	2·3	·6	·62	·62
	1·7	·7	·69	·69
	1·0	·8	·81	·81
	0·4	·9	·92	·92

Rolf's values for $b = 5°$ are slightly higher than those calculated from Pol and Norton. There is better agreement when the values of q are very small. The agreement is perfect for $b = 0$. It should be remembered that Van der Pol's formula is valid only when $\sigma > \frac{2\pi c\epsilon}{\lambda}$. A little calculation will show that for this condition to hold, b should be less than 5°. It is therefore expected that for b greater than 5°, the values of attenuation calculated according to Pol will be discrepant.

We can therefore say that so far as we can test Rolf's attenuation curves *within the range of validity of the empirical formulæ*, the error pointed out by Norton does not appear to materially alter these curves at least for very short distances from the transmitter.

Whether the peculiar features in Rolf's graphs, *viz.*, the negative attenuation and the 'dips', exist according to Sommerfeld's theory cannot, however, be ascertained from Norton's formula. Fresh mathematical investigation is necessary to test these points.

S. R. KHASTGIR.

Physical Laboratory,
Dacca University,
August 19, 1935.

[1] Norton, *Nature*, June 8, 1935, **135**, 955.
[2] Rolf, *Proc. I. R. E.*, March 1930, **18**, Part I.
[3] Sommerfeld, *Ann. der Physik.*, 1909, **4**, 28, 665; *Ann. der. Physik.*, **1926**, **81**, 1135.

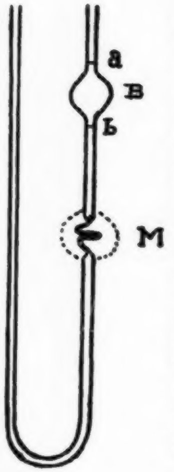
Influence of Magnetic Field on the Coefficient of Viscosity of Liquids.

IN view of the fact that Raha and Chattarjee[1] have recently published a paper on the influence of magnetic field on the coefficient of viscosity of liquids, it may be of interest to record an earlier attempt of mine, in 1932, in which a similar study was undertaken by a different method. The observed variation in the coefficient of viscosity due to the magnetic field being much less than 0·5 per cent., the results of the experiment were considered to be indecisive. The method employed and the results obtained were however included in my M.Sc. thesis, submitted in 1933 to the Mysore University, as an appendix, which runs as follows:

"*Viscosity measurements in a magnetic field.* In order to formulate a theory of viscosity of liquids and to derive an expression for its temperature coefficient Andrade[2] has made the assumption that the viscous force between layers in relative motion is due to transitory binding between molecules in the two layers. G. W. Stewart[3] has supported Andrade's view making use of the information derived from X-ray diffraction of liquids. His work has revealed the existence of constantly fluctuating 'liquid crystalline groups', which are due to molecular field in liquids. Hence the force between successive layers in relative motion is due to 'transitory and fluctuating crystallisation of liquid molecules'.

"Since molecules and molecular groups of several substances, especially those of aromatic compounds, have been found to possess magnetic anisotropy, they might be expected to experience a preferential orientation in a magnetic field, so far as thermal agitation allows them to do so. With a view to test if such an orientation affects the force between successive layers in relative motion and thus alter its coefficient of viscosity, measurements were carried on benzene by comparing the time of flow of the liquid through a constriction in a viscometer, when a magnetic field was acting at the constriction with that when it was not.

"The viscometer employed is shown in the figure and the constriction was a narrow capillary bent as shown in the figure. This was designed to suit the measurement in a magnetic field and was blown out of pyrex glass. The viscometer is so placed that the constriction lies in the narrow space between the poles of a Dubois magnet. In order that the tractive force might not affect the rate of flow of the liquid, care was taken to see that the bulb B was well above the pole pieces. The zig-zag path of the capillary keeps the liquid for a long time in the field. Liquid was sucked until the bulb B and the tube above it were filled with the liquid. When the liquid began to flow down the times taken by the liquid to travel from the mark *a* to *b* were noted both when the magnetising current was on and off, a number of times. The total time taken for the flow was 3 minutes and 15 seconds and in a few observations with the field on it came out as 3 minutes 14 seconds; but in other cases it was equal to the value in the absence of the field. It is inferred therefore that the magnetic field has no appreciable influence on the viscosity of a liquid. This might be due to a small fraction of the liquid molecules orienting themselves in the magnetic field. G. W. Stewart[4] has observed that appreciable orientation occurs in the milky state, very near the melting point (116° C.), in the case of para-azoxyasinol and that this orientation becomes almost negligible when the temperature of clearing (134° C.) is passed. An attempt will be made to conduct the above experiment having liquids at a few degrees above their melting points."



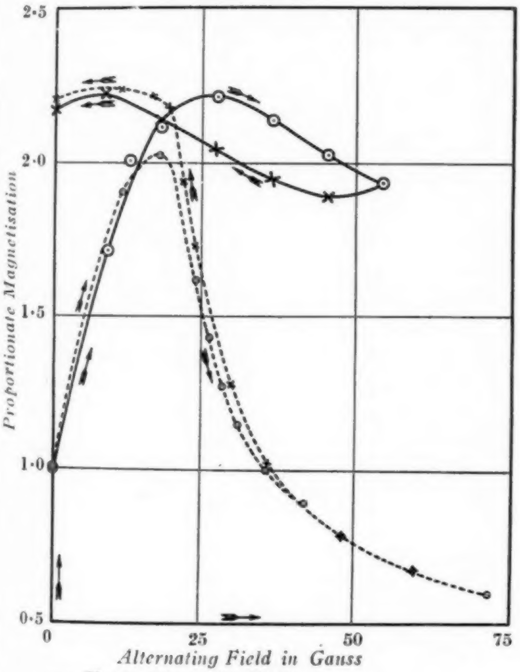
H. S. VENKATARAMIAH.

Department of Physics,
Central College,
Bangalore,
August 21, 1935.

[1] *Ind. Jour. Phys.*, 1935, **9**, 445–454.
[2] *Nature*, 1930, **125**, 582.
[3] *Nature*, 1931, **125**, 727.
[4] *Phys. Rev.*, 1931, **38**, 931–942.

The Phenomenon of Negative Hysteresis in Nickel.

PROCOPIU[1] has studied the influence of an alternating circular or longitudinal field on the intensity of magnetisation of Iron and Steel in a constant magnetising field. The work has been extended to the case of Soft Iron and Nickel. The specimens in the form of wires were first put to a few complete magnetisation cycles in zero alternating field, and ultimately left in a weak magnetic field, so that the magnetisation had a small positive value. The alternating field was then gradually increased to a convenient value and then decreased subsequently. The longitudinal field was produced by passing an alternating current through a solenoid surrounding the specimen, and the circular alternating field, by passing an alternate current through the substance itself. The results for nickel are given in Fig. 1. The circular



— Circular Alternating Field
(Constant Magnetic Field—19·30G).
---- Longitudinal Alternating Field
(Constant Magnetic Field—19·54G).

alternating field refers to the field at the periphery of the wire and was calculated according to the formula $H = \frac{2I}{10r}$, where 'I' is the strength of the alternating current, and 'r' the radius of the specimen.

The result in the case of Soft Iron is essentially the same as Procopiu's, with the difference that a slight hysteresis is noticeable even in the descending part of the curve, which was absent in Procopiu's work. In the case of Nickel in alternating longitudinal field, the effect is similar in nature to that in the case of Iron, but in the alternating circular field, the behaviour of Nickel is anomalous. The curve for decreasing alternating field goes below that for the increasing field and a loop is formed between the two curves, thus showing Negative hysteresis.

A similar effect of Negative hysteresis has been noticed by several workers[2] in the Magneto-Resistance change of Nickel and has been ascribed by Stierstadt[3] to the previous magnetic treatment of the specimen, but its exact nature has not been understood as yet. It is significant that this Negative hysteresis appears only when a current passes through Nickel, as in the case of the alternating circular field and not in the case of the alternating longitudinal field, where no alternating current passes through the specimen. The occurrence of the effect in the Magneto-Resistance change, where again a current passes through the specimen, suggests that Negative hysteresis is connected with some aspect of the movement of conductivity electrons. The effect is no doubt real and an intensive study of the phenomenon is required for throwing light on this anomalous behaviour of Nickel.

The experiment was performed in the Physics Laboratory of the Patna Science College and my best thanks are due to the authorities for kind permission, specially to Prof. K. Prosad, I.E.S., for his constant interest in the work. I also wish to thank Dr. M. M. Sen Gupta, Senior Professor of Physics, Ravenshaw College, Cuttack, for helpful discussions.

S. SHARAN.

Ravenshaw College,
Cuttack,
September, 1935.

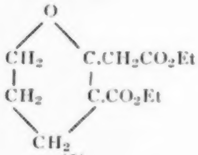
[1] S. Procopiu, *J. de Physique et le Radium*, 1930, **1**, 365-72.

[2] Fr. Vilbig, *Arch. f. Electrotechnik*, **1929**, **22**, **194**; Sen Gupta and Alam, *Ind. Jour. Phys.*, (8) **33**, p. 9.

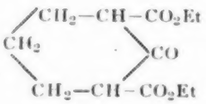
[3] O. Stierstadt, *Phys. Rev.*, **1931**, (2) **37**, 1356.

Action of Trimethylene Bromide on Acetonedicarboxylic Ester: A New and More Convenient Method of Synthesis of Ethyl *Cyclo*-hexane-2 : 6-Dicarboxylate.

PERKIN[1] obtained ethyl methyldehydrohexonedicarboxylate (I) by the action of trimethylene bromide upon Na-derivative of ethyl acetonedicarboxylate in alcoholic medium; the corresponding di-acid, m.p. 185°–92°, and the mono-acid mono-ester, m.p. 115°. The reaction was tried in dry benzene suspension by heating for nearly 100 hours at 140°–50° in sealed soda water bottles with the expectation that ethyl *cyclo*hexanone-2 : 6-dicarboxylate, if formed under these conditions, would furnish a convenient starting material for the study of some 1 : 3-bridge formation in the *cyclo*hexane molecule. The reaction mixture was separated into two portions—petrol soluble and petrol insoluble. The former, about half of the whole in quantity, gave a liquid, b.p. 142°/2 mm. along with some unreacted ester and ethyl acetoacetate. The ester, b.p. 142°/2 mm. gave on hydrolysis a dibasic acid, m.p. 172°, and a mono-acid mono-ester, m.p. 83°, agreeing in composition with Perkin's compounds, which are isomeric with ethyl *cyclo*hexanone-2 : 6-dicarboxylate and its derivatives. From the petrol insoluble portion, the phenolic lactone, m.p. 188°[2] was isolated amongst other products not identified.



(I)



(II)

Having found the reaction of sodium or sodium ethoxide, upon acetone dicarboxylic ester is always attended with the formation of phenolic bodies and according to Perkin of compounds containing oxygen in the ring, it was considered desirable to try a milder metallic derivative. Trimethylene bromide reacts with the magnesium derivative of acetone dicarboxylic ester to yield the expected ethyl *cyclo*hexanone-2 : 6-dicarboxylate (II) b.p. 144°/3 mm.; phenyl hydrazone, m.p. 150°, mixed m.p. with a genuine sample remaining undepressed. This new method is more convenient to work with and the yield compares favourably with that obtained by the older method.

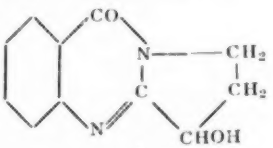
This new observation as also the formation of a suberone derivative[3] and of a *cyclo*pentanone derivative[4] from Na-derivative of acetone dicarboxylic ester establish definitely that under suitable conditions itcan react in the ketonic form lending itself to the formation of homocyclic compounds and not only in the enolic form as observed by Perkin.

P. C. GUHA.
N. K. SESHADRIENGAR.
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
September, 1935.

[1] *J. C. S.*, **1887, 51,** 739.
[2] Jerdan, *J. C. S.*, **1887, 71,** 1106.
[3] Braun, *Ber.*, **1913, 46,** 1792.
[4] Ingold, *J. C. S.*, **1928,** p. 365.

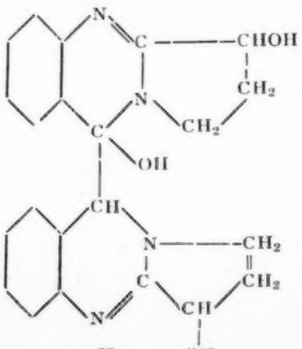
The Oxidation Products of Vasicine with Hydrogen Peroxide.

MORRIS, HANFORD AND ADAMS[1] have found that vasicine does not react with 3% H_2O_2 as stated by Ghose[2] *et al* but does so with 30% H_2O_2 and on interaction at 60°–70° it gives a compound m.p. 214° as stated by Ghose *et al*. To this compound, they have assigned the structure (I).



I

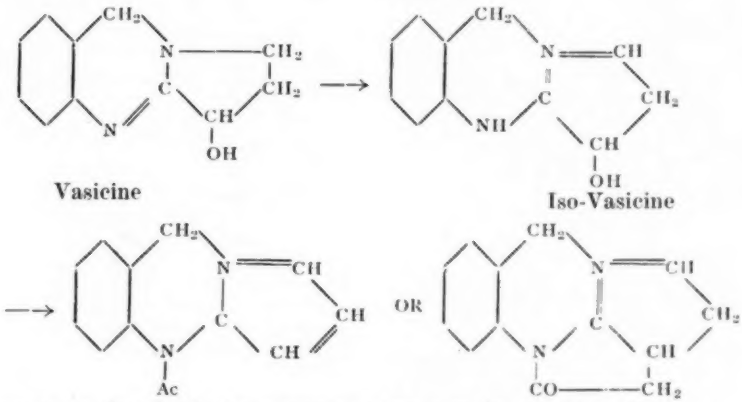
But a second product m.p. 168° obtained by Ghose *et al* was not found and they are of opinion that it was an equi-molecular mixture of I and vasicine.



II

The strength of hydrogen peroxide stated by us to be 3% was a typographical error for 30%. Repeated experiments have invariably yielded the substance m.p. 168° and the constant analytical values obtained after crystallisation justify the view that it cannot be a mixture. Under the microscope the substance has a homogeneous appearance. Its formula was given by Ghose *et al* as $C_{11}H_{10}NO$; $\frac{1}{2}H_2O$. It is probably $2(C_{11}H_{10}NO;\ \frac{1}{2}\ H_2O)$, *i.e.*, $C_{22}H_{22}N_2O_3$ and its structure represented by II as it is almost quantitatively oxidised by H_2O_2 to I.

The acetyl derivative of vasicine was obtained as an oil by Spath, contrary to Ghose *et al* who record a m.p. 164°. It was this discrepancy which at one time suggested the possibility of vasicine being different from peganine. It is gratifying to note that Spath, Kuffner and Platzer[3] now find the m.p. to be 163–164°·5 in confirmation of Ghose *et al.* Its structure can be represented as below :

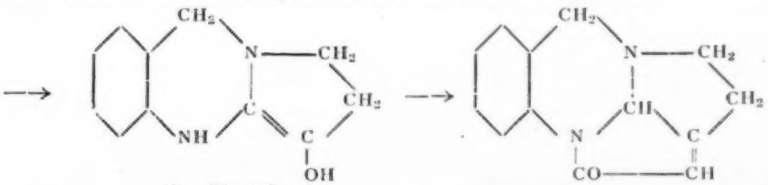


Vasicine

Iso-Vasicine

It is more probable that both the nitrogen atoms remain trivalent, thus :

Vasicine



Iso-Vasicine

T. P. GHOSE.
S. KRISHNA.
K. S. NARANG.
J. N. RAY.

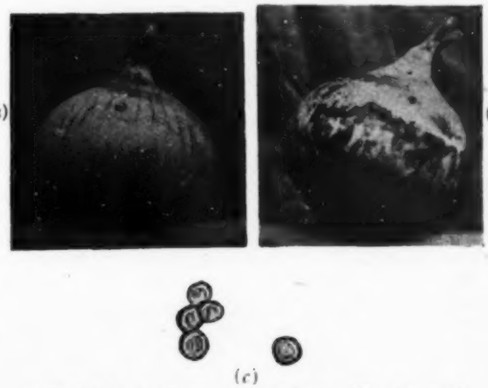
University Chemical
Laboratories, Lahore,
September 6, 1935.

[1] *J. Am. Chem. Soc.*, 1935, **57**, 954.
[2] *British Chem. Abstracts*, 1933, **A 1**, 77.
[3] *Ber.*, 1935, **68**, 935.

Storage-Rot of Onions.

IN 1932 the attention of the senior writer was attracted towards this serious disease, which caused a waste of more than half to his onion-store. Although exceedingly common, no mention about it is found in Butler's *Fungi and Disease in Plants* (1918), *The List of Specimens in the Mycological Herbarium, Pusa* (1921), *The Fungi of India, Calcutta* (1931), *The Fungi of Bombay* (1935). The causal agent, an *Aspergillus* sp. in spite of

(*a*)



(*b*)

(*c*)

Baroda White Onions: (*a*) healthy, (*b*) diseased, (*c*) spores of the malady through oil immersion.

its existence in the soil, has never been found to be parasitic on the living plant. It attacks only the mature bulbs. Observations taken on different modes of storage showed the decay in (1) heaps 47·5%, (2) one layer spread on rice straw 14·6%, (3) store in well-ventilated hanging baskets 15%, and lastly (4) four to five onions woven together by their leaves and hung on a string 15%. Isolated cultures of the organism showed best growth at 34°–35° C. in the multiple incubator.

Walker and Murphy[1] have described an identical rot on onions and garlics imported in the States from Italy. *Botrytis Allii*, Munn. has been long known as Neck Rot of onions both in America and Europe and is seen to attack the inflorescence. The Indian organism seems to differ specifically from the *Aspergillus* described from America. Further observations as to the mode of attack of the organism, its physiology and its response to different methods of storage and chemical treatments are continued.

V. N. LIKHITE.
G. H. DESAI.
Research Laboratory,
Agricultural Experimental Station,
Baroda,
August, 1935.

[1] *Phytopathology*, March 1934.

A Somewhat Cosmopolitan Parasite—*Loranthus longiflorus*.

WITH reference to the article by Mr. Srivastava[1] we wish to point out that at least in Hyderabad the occurrence of *Loranthus longiflorus* on the following host-plants, many of which to our knowledge at least have not been mentioned by previous writers, has long been recorded, but the publication was detained in order to find out as many hosts as possible of this parasite. Mr. Srivastava mentions two of the new hosts which we have recorded.

1. *Psidium guayava.*
2. *Melia azadirachta.*
3. *Cordia myxa.*
4. *Anona squamosa.*
5. *Punica granatum.*
6. *Tamarindus indica* (very rarely).
7. *Citrus aurantium.*
8. *Millingtonia hortensis.*

As has been mentioned by other writers *Loranthus* is a branch parasite and flowers profusely about the months of June and July. The following hosts of *Loranthus longiflorus* are mentioned by different writers. *Bassia latifolia* and *Diospyros Melanoxylon* are recorded by Partridge.[2] Cooke[3] states that it is common on mango trees in Bombay and throughout the Konkan. Duthie[4] mentions that it is parasitic especially on mango, neem and mahua. Hooker[5] mentions nothing about the host-plants of *Loranthus*. Keeble[6] gives a beautiful account of the *Loranthaceæ* of Ceylon describing in detail the fertilization of the flower, mode of distribution of seeds, etc., but does not mention the hosts. Although this parasite is becoming somewhat cosmopolitan it is worth while recording from time to time in different localities on what new hosts it spreads. Evidently there does not seem to be any specialisation of hosts in this parasite.

Nectar fills the corolla-tube in *Loranthus longiflorus*. In addition to this Keeble mentions that "a drop is lodged behind the base of each filament between it and the corolla-lobes". It attracts small insects and birds. The latter seem to be the chief fertilizing agents. Their gentle tap breaks open the corolla-lobes which were hitherto closed. Keeble suggests that "this remaining closed of the ripe flowers is an instance of close relationship, beneficial to both parties, between flower and fertilizer; the bird knows it is worth its while to 'tap a new barrel' as it were; moreover, the parts of the flower are protected from the damaging effects of exposure to wet." It is so indeed. In the majority of the *Loranthaceæ* the seeds are dispersed by the agency of birds and in some cases by the explosions of the fruits as Dr. B. Sahni[7] states. Engler and Prantl[8] in their account of the distribution of the seeds conclude by saying that "The stickiness (of the viscin) enables some seeds, falling from branch to branch, to become attached; on the other hand, birds bite up the fruits and throw away the seed which is surrounded by the viscid layer" and further that seeds often pass unharmed through the gut of birds and may then germinate. Our own observations confirm much of what has been quoted. It is a very common observation that according to the nature of the fruit-coat and the seed that birds reject the former or the latter. In the case of the fruit-coat of *Loranthus* we know that it contains a lot of tannin, and hence it does not appeal to the birds which extract the seed with the pulp from the fruit and reject the coat.

FIG. 1. *Loranthus longiflorus* (Loranthaceæ) parasite on *Melia azadirachta* (Meliaceæ).

FIG. 2. *Loranthus longiflorus* (Loranthaceæ) parasite on *Cordia myxa* (Boragineæ).

FIG. 4. *Loranthus longiflorus* (Loranthaceæ) parasite on *Citrus aurantium* (Rutaceæ).

FIG. 3. *Loranthus longiflorus* (Loranthaceæ) parasite on *Punica granatum* (Myrtaceæ).

Although the birds eat away the pulp and get rid of the seeds by wiping or stricking their beaks against branches or other objects, occasionally some of them are swallowed. Out of these a few pass unharmed through the gut and germinate quite well while others are destroyed by the digestive juices in the gut. However, this fact is an established one that birds are responsible for the dissemination of seeds in *Loranthus*.

As a result of the attack of *Loranthus* on its hosts, outgrowths of considerable size and peculiar complicated shape result. Ultimately the host becomes almost brittle and falls down. Further observations are being made.

M. SAYEED-UD-DIN.
M. A. SALAM.

Osmania University,
Hyderabad, Deccan,
September, 1935.

[1] Srivastava, G. D., *Curr. Sci.*, 1935, **4**, 106.
[2] Partridge, E. A., *Forest Flora of Hyderabad*, 1911, 343.
[3] Cooke, T., *Flora of the Bombay Presidency*, 1903-08, **2**.
[4] Duthie, J. F., *Flora of the Upper Gangetic Plain*, 1903-20, **2**.
[5] Hooker, J. D., *Flora of British India*, 1875-79, **4**.
[6] Keeble, F. W., *Trans. Linn. Soc.*, 1896, **S 2**, Pt. 3.
[7] Sahni, *Jour. Ind. Bot. Soc.*, 1933, **12**, 2, 96.
[8] Engler and Prantl, *Die Naturlichen Pflanzenfamilien*, Teil **3**.

Double Parasitism of *Loranthus* and *Viscum* on Eugenia.

Loranthus is a very common parasite of flowering plant all over Western India. It has numerous hosts which include a number of cultivated plants. The species *longiflorus* is the commonest and is found very extensively both on cultivated and wild plants. *Viscum*, on the other hand, is less common and is usually found in thick forests and in shady places. I have never seen *Loranthus* parasitic on Myrtaceæ but a case has recently been reported by Mr. G. D. Srivastava[1]. I am therefore inclined to record another case of a similar kind but still more interesting. In July last I observed a *Loranthus* parasitic on a tall plant of *Eugenia jambolana* and when the specimen was collected I discovered that it has itself been parasitised by *Viscum articulatum*, the *Loranthus* being a parasite directly on Eugenia.

The parasitism of *Loranthus* on Myrtaceæ is certainly rare but such a case of *Viscum* on *Loranthus* and *Loranthus* on *Eugenia jambolana* is certainly very rare and is worth recording. Perhaps such double parasitism is seen in the deeper forests of the Thana District where this plant was found, but I know of no record of the kind.

MOSES EZEKIEL.

Biology Department,
Wilson College, Bombay.
September 4, 1935.

[1] *Curr. Sci.*, 1935, **4**, 106.

N.B.—Since writing the above I saw in the Victoria Gardens, Bombay, *Loranthus longiflorus* parasitic on *Callistemon linearis* (*C. coccinia*, the Australian Bottle Brush), a member of the family Myrtaceæ. This fact is worth noting because *Callistemon* is an introduced garden plant, and more so because this garden is remarkably free from *Loranthus* parasites, this case being one of the very few in the garden.
September 9*th*, 1935. M. EZEKIEL.

Chromosome Numbers in Two Species of *Hibiscus* (*H. sabdariffa* L. and *H. cannabinus* L.).*

THE genus *Hibiscus* belongs to the fairly big family of Malvaceæ which includes a great many familiar plants of cultivation, notably cotton. Cytological work on this economically important family is receiving greater attention in recent times and the work of Davie (1934)[1] gives a comprehensive survey of results obtained. While the cytology of the genus *Gossypium* has been worked out in some detail by several authors that of other genera has not received so much attention. In the genus *Hibiscus* itself only nine species have been examined for their chromosome numbers which reveals polyploidy with high chromosome numbers. The author, while at Pusa, examined cytologically two other species, namely *H. sabdariffa* and *H. cannabinus* for their chromosome numbers and the results are embodied in this note.

Root tips of a pure line of *H. cannabinus* and several varieties of *H. sabdariffa* were fixed in Allen's modification of Bouin's fluids at different times of the day and after the usual dehydration, clearing, and embedding, cut into sections from 10-12μ thick and stained with Haidenhain's Hæmatoxylin. Drawings were made with the aid of a camera lucida at a magnification of 2500. It was found that under conditions obtaining at Pusa, cell divisions started as early as 10 A.M. and continued till 3 P.M. with a maximum phase in the middle, after which there was a cessation and a renewed activity

(*Continued on p.* 175.)

SUPPLEMENT TO "CURRENT SCIENCE".

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Norwich, 1935.

The Presidential Address.

Form, Drift and Rhythm of the Continents.

By Professor W. W. Watts, LL.D., SC.D., F.R.S.,
President of the Association.

It is now sixty-seven years since the British Association enjoyed the hospitality of the city of Norwich, a privilege which is being renewed to-day under the most happy auspices.

At that meeting we find the scientific community was particularly interested in underground temperatures and tidal phenomena, in the application of the spectroscope to celestial objects, and in the discovery of the oldest Cambrian fossils and the earliest fossil mammals then known. Many papers were read on local natural history, including those on Norfolk farming and the drainage of the County and of the Fens.

In his address at the meeting the President, Sir Joseph D. Hooker, made special reference to the work of Charles Darwin: not to the *Origin of Species* which had been acrimoniously discussed by the Association on previous occasions, and notably at Oxford in 1860, but to some of the work that followed.

It should be remembered that Hooker was one of the three scientific men, representing botany, zoology and geology, whom Darwin had selected as judges with whose opinion on the soundness of his theory of the origin of species he would be content. The others were Huxley and Lyell; and of the three Lyell was the hardest to convince, chiefly because the record of life in the past then furnished by the rocks was manifestly so incomplete and unsatisfactory that its evidence was insufficient to warrant a definite verdict.

Lyell had set out to 'treat of such features of the economy of existing nature, animate and inanimate, as are illustrative of geology,' and to make 'an investigation of the permanent effects of causes now in action which may serve as records to after ages of the present condition of the earth and its inhabitants.' By laborious study of the work of others, and by his own extensive travel and research, he had been able to enunciate, for the inorganic world, the principle of uniformitarianism, which in its original form we owe to Hutton. This principle involved that the history revealed by the rocks should be read as the effect of the slow but continuous operation of causes, most of them small, such as could be seen in action in some part or other of the world to-day. This was set in opposition to the opinion of the older geologists who had postulated a succession of catastrophes which, by flood, fire and convulsion, had periodically wrecked the world and destroyed its inhabitants; each catastrophe necessitating a new creation to provide the succession of life on the earth as it then was known.

But in the organic world Lyell, like Hutton, had failed to detect any analogous principle, and, as he rejected all the theories of transmutation of species then in vogue, he had to accept their absolute fixity; and to suppose that, as species became extinct one after another, replacement by special creations followed. And yet the reading to-day of the chapters devoted to this branch in the earlier editions of Lyell's great work produces the haunting feeling that a better explanation had only just eluded him. It was the story revealed in Lyell's work, Darwin tells us, the new conception that the earth had been in existence for vast æons of time, the proof that it has been continuously peopled by animals and plants, and that these had steadfastly advanced and improved throughout that time, which showed him the necessity for an explanation of the progression of life, and gave him the first hints of his theory. When he had enunciated this he was enabled to repay his master with the principle of organic evolution, which brought changes in the animate world into harmony with those of the inanimate.

His *Antiquity of Man* shows that by

1863 Lyell had become a convert, and he afterwards rewrote much of the second volume of his *Principles* accepting the new point of view. This change earned from Hooker a testimonial in the 1868 address which, if not unique, must certainly be one of the most magnificent ever awarded to a scientific work:

'I know no brighter example of heroism, of its kind, than this, of an author thus abandoning, late in life, a theory which he had regarded as one of the foundation stones of a work that had given him the highest position attainable amongst contemporary scientific writers. Well may he be proud of a superstructure, raised on the foundation of an insecure doctrine, when he finds that he can underpin it and substitute a new foundation; and, after all is finished, survey his edifice, not only more secure, but more harmonious in proportions than before.'

Although infinitely richer than when Darwin wrote, the Geological Record still is, and must from its very nature remain, imperfect. Every major group of animal life but the vertebrates is represented in the Cambrian fauna, and the scant relics that have been recovered from earlier rocks give very little idea of what had gone before, and no evidence whatever as to the beginnings of life.

But, from Cambrian time onward the chain of life is continuous and unbroken. Type after type has arisen, flourished and attained dominion. Some of them have met extinction in the heyday of their development; others have slowly dwindled away; others, again, have not finished their downhill journey, or are still advancing to their climax.

Study of the succession of rocks and the organisms contained in them, in every case in which evidence is sufficiently abundant and particularly among the vertebrates and in the later stages of geological history, has now revealed that the great majority of species show close affinities with those which preceded and with those which followed them; that, indeed, they have been derived from their predecessors and gave origin to their successors. We may now fairly claim that palæontology has lifted the theory of evolution of organisms from the limbo of hypothesis into a fact completely demonstrated by the integral chain of life which links the animals and plants of to-day with the earliest of their forerunners of the most remote past.

Further, the rocks themselves yield proof of the geographical changes undergone by the earth during its physical history; and indicate with perfect clearness that these changes have been so closely attendant on variation in life, and the incoming of new species, that it is impossible to deny a relation of cause and effect.

Indeed, when we realise the delicate adjustment of all life to the four elements of the ancients which environ it, air, water, earth and fire; to their composition, interrelationships and circulation; it is perhaps one of the most remarkable facts established by geology that, in spite of the physical changes which we know to have occurred, the chain of life has never snapped in all the hundreds of millions of years through which its history has been traced.

The physical changes with which Lyell and his successors were most closely concerned were, firstly, the formation of stratified rocks on horizontal sea-floors, situated in what is now often the interior of continents, far removed from the oceans of the present day, and thus indicating important and repeated changes in the position of land and water; and, secondly, the deformation of these flat deposits till they were rucked and ridged to build the mountain ranges.

Before and since Lyell's time geologists have devoted themselves to working out the exact and detailed succession of these stratified rocks, translating their sequence into history and their characters into terms of geography; the succession of physical conditions prevailing at the time of their formation. Further, although animals and plants migrate from place to place, the time occupied by the migrations of suitable forms is so negligible when compared with the length of the chapters of geological history that their fossil remains have proved to be the best means for correlating strata over broad stretches of the earth's surface. This correlation has converted the fragments of local history thus revealed into at least the outlines of the geological story of the world.

It was not till 1885, however, that the accumulation of data of this type was sufficient to enable the great geologist, Suess, an Austrian but born in this country, to assemble and correlate them, and to deduce from them further principles which have been the mainstay and inspiration of his successors. We owe to Hertha Sollas and her father the rendering of this great work, *The Face of the Earth*, into English; and to Emmanuel de Margerie and his colleagues a French translation enriched

with a magnificent series of maps and sections such as could only have been brought together by one with the most remarkable bibliographic knowledge ; a veritable recension of the original.

The nature and associations and the distribution in time and space of modern changes in the relative levels of land and sea, as detected at sea-margins and by altitude survey, and of older changes betrayed by such evidence as submerged forests and raised beaches, had convinced geologists that the unstable element was not the fickle and mobile sea, but the solid if elastic earth-crust. They naturally applied the same explanation to those encroachments of the sea in the past which had resulted in the formation of our stratified rocks. But while some investigators were content with one form of movement—that due to lateral pressure—to explain both the formation of mountains and the rise and fall of the land, others called in a different cause for the latter. Without entering into a discussion of causes it may be well for us to distinguish the orogenic or mountain-forming from the epeirogenic or continental movement.

The evidence collected by Suess proved that these last great land and sea changes had occurred simultaneously over whole continents or even wider regions. Such great submergences as those to which the Cambrian Rocks, the Oxford Clay and the Chalk are due were of this character ; while, in between, there came times of broad expansions of continental land and regressions of the sea. These changes were in his view on far too grand a scale to be compared with, or explained by, the trivial upheavals and depressions of land margins of the present day, which he showed could mostly be correlated with volcanoes or earthquakes, or with such incidents as the imposition or relief of ice-sheets on an elastic crust in connexion with glacial conditions.

It became necessary for him to replace or supplement oscillations of the earth-crust by a world-wide periodic ebb and flow of the oceans, to and from the continents ; positive movements of transgression carrying the sea and its deposits over the lands, drowning them and their features under tens or hundreds of fathoms of water ; and negative movements or regressions when the oceans retreated to the deeps, leaving the continents bare or encrusted with recently formed sediments.

Although the facts cried out for this generalisation Suess was at a loss to supply any mechanism competent to produce the wonderful rhythm. The problem was difficult because a liquid must maintain a horizontal, *i.e.*, an equipotential, surface. It was manifestly impossible to withdraw from the earth, and later to replace upon it, the vast quantity of water that would be required ; and, though a shifted water-level, or even a varied water-surface relative to the continents, might be caused by polar ice-caps, by redistribution of the continents carrying their local effects on gravitation, by variations in the rate of the earth's rotation, or other far-reaching causes, none of these would supply an explanation that fitted all the facts. Regressions of the sea could be to some extent explained if Suess's main postulate, that the great ocean basins had been slowly sinking throughout geological time, were granted. But this explanation only rendered more impotent the raising of ocean levels by deposits of sediment, and this was almost the only valid cause for transgressions that he had been able to suggest.

Further, it is not possible to ignore the definite relationship that exists between the pulsation of the oceans and the raising of mountains by lateral or tangential stress. Periods of positive movement or advance of the seas were times of comparative tranquillity, when tangential pressure was in abeyance. Periods of negative movement and retreat were invariably marked by the operation of great stresses by which the earth's face was ridged and wrinkled in the throes of mountain-birth.

The theory that continuous cooling and shrinkage of the interior of the earth afforded an explanation of mountain ranges and other rugosities on its surface was a legacy from the nebular hypothesis. In spite of the homely simile of a shrivelling apple, this explanation has never received a very enthusiastic welcome from geologists, though, in default of other resources, they had to make use of it. As knowledge has grown the difficulties have become insurmountable to them.

First, there is its inadequacy to explain the vast amount of lateral movement required to account for the greater mountain ranges ; their rocks, originally spread over a wider area, having been folded and crushed into a narrower width. The shortening of the earth-crust thus effected has been estimated in the case of the Rocky Mountains at 29

miles, of the Himalayas at 62, the Alps at 76, and the Appalachians at the large figure of 200 miles.

Then there is the periodicity of mountain growth. The great epochs of mountain-building, such as the Caledonian, to which the chief Scottish and Welsh mountains are due, the Hercinian, responsible for the Pennine and South Wales, and the Alpine, which gave us 'the wooded, dim, blue goodness of the Weald,' were associated with vast continental development; and each was separated from the next by a period of relative inactivity lasting dozens of millions of years.

Further, there is the fact that the vigour of mountain-building, of volcanoes, and of other manifestations of unrest, has shown no sign of senility or lack of energy. The geologically recent Alpine-Himalayan range is as great, as lofty, and as complicated in structure, as were any of its precursors. The active volcanoes of Kilauea, Krakatao, or St. Pierre, and those recently extinct in Northern Ireland and the Scottish Isles, were as violent and efficient as any of those of the Palæozoic Era. The earth is 'a lady of a certain age,' but she has contrived to preserve her youth and energy as well as her beauty.

But it was when Lord Kelvin's dictum struck from geology its grandest conception, time, that it became vital to re-examine the position. He had demonstrated that, if the earth had been continuously cooling down at its present rate, its surface must have been too hot for the existence of life upon it a limited number of million years ago. The concept of geological time, indicated by Hutton in his famous saying that in this enquiry 'we find no vestige of a beginning —no prospect of an end,' had been confirmed by data accumulated through the painstaking researches of a host of competent and devoted observers all over the world. To them, familiar with the tremendous changes, organic and inorganic, that the earth had passed through since Cambrian time, it was wholly impossible to compress the life story of the earth, or the history of life upon it, into a paltry 20 or 30 million years. The slow growth and slow decay of mountain range after mountain range, each built out of, and in some cases upon, the ruins of its predecessor; the chain of slowly evolving organisms, vast in numbers and infinite in variety; told plainly of long æons of time. And the duration of these æons can be dimly realised when it is recalled that, within a small fraction of the latest of them, man, with the most primitive of implements and the most rudimentary culture, has succeeded in penetrating to the uttermost corners of the world, and developed his innumerable languages and civilisations.

Huxley, as our representative, took up the challenge in his address to the Geological Society in 1869, and asked the pertinent question "but is the earth nothing but a cooling mass 'like a hot water jar such as is used in carriages' or 'a globe of sandstone'?" And he was able to point out at least some agencies which might regenerate the earth's heat or delay its loss.

So it is only fitting that the great physicist, who imposed a narrow limit to geological time, should have prepared the way for those who have proved that the earth possesses in its radioactive substances a 'hidden reserve' capable of supplying a continuous recrudescence of the energy wasted by radiation, thus lengthening out the time required to complete its total loss. These later physicists have given us time without stint; and, though this time is the merest fraction of that envisaged by cosmogonists and astronomers, we are now so much richer than our original estimates that we are embarrassed by the wealth poured into our hands. So far from the last century's urge to 'hurry up our phenomena,' we are almost at a loss for phenomena enough to fill up the time.

The far-sighted genius of Lord Rutherford and Lord Rayleigh first saw the bearing of the rate of disintegration of radioactive substances in the minerals of rocks on the age of the parts of the earth-crust built of them. The extension and supplementing of this work by Joly, Holmes, and others, has now enabled us to look to the disintegration of uranium, thorium, and potassium, as the most promising of many methods that have been used in the endeavour to ascertain the age of those parts of the earth-crust that are accessible to observation. These methods also promise a means of dating the geological succession of Eras and Periods in terms of millions if not hundreds of thousands of years.

The decline and early death to which Lord Kelvin's dictum had condemned the earth, according so little with the vigour displayed in its geological story, is now transformed into a history of prolonged though not perennial youth. It was for

Joly, of whose work the extent, variety and fruitfulness are hardly yet fully appreciated, to take the next step and see in the release of radioactive energy a mechanism which could drive the pulse that geologists had so long felt, and that Suess had so brilliantly diagnosed. As Darwin found the missing word for Lyell, so Joly in his theory of Thermal Cycles has indicated the direction of search for a mechanism to actuate the rhythm of Suess.

In Joly's conception the running down of the earth's energy, though a continuous process, was, through the intervention of radioactivity, converted into a series of cycles, during each of which relative movements of sea and land must occur ; downward movements of the continents, associated with positive encroachments of the sea ; upward movements, with retreat of the sea, the formation of wide land masses, and the ridging of strata to form mountain ranges. Thus he forged a link that could unite the continental or epeirogenic movement with orogenic or mountain movement.

The visible parts of mountains and continents, as well as their lower and hidden portions, or 'roots', are made of comparatively light rocks. In order to stand up as they do their roots must be embedded in denser matter, in which they 'float' like ice-bergs in water. A far larger mass must exist below than is visible above, and the bigger the upstanding part the bigger the submerged root. Over the larger area of the ocean floor, on the other hand, the thickness of material of low density must be very slight, and the denser layer must come close to the surface.

The study of earthquakes, to which the Seismology Committee of the British Association has made outstanding contributions, has yielded, from the times taken in transmission of vibrations through the earth, the best information as to the nature and state of the interior. It has proved that the dense layer is solid at the present time. It is probably no coincidence that the earth is also but just recovering from what is possibly the greatest period of mountain-building, if not the greatest negative movement of ocean retreat, that it has ever experienced.

But solidity cannot be the permanent condition of the substratum. Heat is generated in it by its own radioactivity, but, according to the terms of the hypothesis, cannot escape, in consequence of the higher temperature generated in the continental rocks which cover it. It is therefore retained in the substratum and stored as latent heat of liquefaction, so that, within a period which has been calculated approximately in millions of years, complete melting of the sub-crust must ensue.

The resulting expansion of the liquefied stratum will have at least two effects of great importance to us. In the first place the unexpanded superficial layers will be too small to fit the swelling interior. They will, therefore, suffer tension, greater on the ocean floor than on land, and cracking and rifting will occur, with intrusion and extrusion of molten rock. In the second place the continental masses, now truly floating in a substratum which has become fluid and less dense than before, will sink deeper into it, suffering displacement along the rift cracks or other planes of dislocation. As a result the ocean waters, unchanged in volume, must encroach on the edges of the continents, and spread farther and farther over their surfaces.

Thus we have the mechanism which Suess vainly sought, causing positive movements of the oceans, their waters spreading over wide stretches of what was formerly continental land, and laying down as sediment upon it the marine stratified rocks which are our chief witness of the rhythmic advances of the sea.

This condition, however, cannot be permanent, for by convection of the fluid basic substratum, supplemented by the influence of tides within it, and the slow westward tidal drag of the continental masses towards and over what had been ocean floor, there will now be dissipation of its heat, mainly into the ocean waters, at a rate much faster than it has been or could be accumulated. Resolidification ensues, and again there are two main consequences. First, the stratum embedding their roots having now become more dense, the continental masses rise, and as they do so the ocean waters retreat from their margins and epicontinental seas, leaving bare as new land, made of the recently deposited sediments, the areas previously drowned. Secondly, the expanded crust, left insufficiently supported by the withdrawal of shrunken substratum, will suffer from severe tangential stress, and, on yielding, will wrinkle like the skin of a withering apple. The wrinkles will be mountain ranges, formed along lines of weakness

such as those at continental margins; and they will be piled up and elevated to suffer from the intense erosion due to water action upon their exposed and upraised rocks.

In this, again, we have a mechanism which supplies what was needed by Suess, and one, moreover, which secures the required relationship between continental and mountain movement, between the broader extensions of continental land and the growth of mountains with their volcanoes and earthquakes and the other concomitants of lateral thrust.

Thus a Thermal Cycle may run its full course from the solid substratum, through a period of liquefaction accompanied by crustal tension, back to solidification and an era of lateral stress: and the stage is set for a new cycle.

Professor Arthur Holmes, in checking Joly's calculations, has concluded that the length of the cycles in a basic rock substratum should occupy from 25 to 40 million years, a period much too short to fit the major periods of mountain movement, as determined by him from the radioactivity of minerals contained in the rocks. On this evidence the Alpine movement should date back from 20 to 60 millions of years ago, the Hercynian 200 to 250 millions, and the Caledonian from 350 to 375 million years.

In a preliminary attempt to modify Joly's hypothesis Holmes postulated the occurrence of similar, but longer cycles (Magmatic Cycles) in a denser, ultrabasic layer underlying the basic one, the rhythm of which would be nearer to 150 million years. The shorter cycles due to the basic layer are held in part responsible for periods of minor disturbance, and also to account for the individual variations in effect, duration, and intensity of the larger ones. Each of the later movements has also evidently been limited and conditioned by the results of foregoing ones, and especially by areas of fracture and weakness on the one hand, and by large stable masses composed of rocks intensely consolidated, or already closely packed, on the other.

More recently Holmes has developed the possibility that the loss of heat is mainly due to convection in the liquid substrata, and that convection is the leading cause of the drifting and other movements of the crust, and the disturbances that have occurred in it. He says:—

'Although the hypothesis involving sub-crustal convection currents cannot be regarded as established, it is encouraging to find that it is consistent with a wide range of geological and geophysical data. Moreover, it is by no means independent of the best features of the other hypotheses. It requires the local operation of thermal cycles within the crust, and it necessarily involves contraction in regions where crustal cooling takes place. It is sufficiently complex to match the astonishing complexities of geological history, and sufficiently startling to stimulate research in many directions.'

The phenomena are difficult to disentangle as the number of operating causes has been so great and many of them are not fully understood. But, underlying them all there is unquestionably the pulse within pulse which Suess saw and of which Joly pointed the way to explanation.

The view at which we have arrived is neither strictly uniformitarian nor strictly catastrophic, but takes the best from each hypothesis. As Lyell showed, most of the phenomena of geology can be matched somewhere and sometime on the earth of to-day; but it would appear that they have varied in place, intensity, phase, and time. And, as Lyell was driven to accept *evolution* to explain the history of life on the earth, so must we employ the same word to express the life-processes of the earth itself, as was suggested by Huxley in 1869 and strongly advocated by Sollas in 1883.

The contrast in outline and structure between the Atlantic and Pacific Oceans had long been noted when Suess formulated and used the differences as the basis of his classification.

The Pacific is bounded everywhere by steep slopes, rising abruptly from profound ocean depths to lofty lands crowned with mountain ranges, parallel to its shores and surrounding its whole area. On the American side the Coast Range is continued by the Andes. On the Asiatic side chains of mountainous peninsulas and islands, separated from the continent by shallow inland seas, extend in festoons from Kamchatka and Japan to the East Indies, eastern Australia and New Zealand. This mountain ring, as Charles Lapworth said, 'is ablaze with volcanoes and creeping with earthquakes,' testifying that it has been recently formed and is still unfinished.

The Atlantic Ocean, on the other hand, is not bordered with continuous ranges, but breaks across them all: the Scottish and Welsh ranges, the Armorican range, the continuation of the Pyrenees and Atlas; and, on the American side, the uplands of

Labrador, Newfoundland and the eastern States, and the hill ranges of Guiana and Brazil. The Atlantic is in disconformity with the grain of the land, while the Pacific conforms with it. The Pacific has the rock-folds of its ranges breaking like ocean waves towards it as though the land were being driven by pressure to advance upon it, while the Atlantic recalls the effects of fracture under tension.

The middle and southern edges of the Atlantic, however, agree to some extent with the Pacific type. The Caribbean Sea, with the Antilles and the rest of its border girdle, recalls the similar structure of the Mediterranean, as it stretches eastwards, with breaks, to the East Indian Archipelago; while the Andes are continued to Antarctica in a sweeping curve of islands. The rest of the Indian Ocean is of Atlantic type, as seen in the shores of eastern Africa and western Australia.

Another feature of the Atlantic is the parallelism of much of its eastern and western coasts, the meaning of which has often attracted the speculations of geologists and geographers. With a little stretch of the imagination, and some ingenuity and elasticity of adjustment, plans or maps of the opposite sides may be fitted fairly closely, particularly if we plot and assemble the real edges of the continents, the steep slopes which divide the 'shelves' on which they stand from the ocean depths. This has suggested the possibility that the two sides may once have been united, and have since broken and drifted apart till they are now separated by the ocean.

This view, outlined by others, has been emphasised by Wegener and dealt with by him in full detail in his work on *The Origin of Continents and Oceans*, and it now plays a leading part in what is known as the Wegener theory of continental drift. The hypothesis is supported by the close resemblances in the rocks and fossils of many ages in western Europe and Britain to those of eastern North America; by community of the structures by which these rocks are affected; and by the strong likeness exhibited by the living animals and plants on the two sides, so that they can only be referred to a single biological and distributional unit, the Palæarctic Region.

The hypothesis, however, did not stop at this; and in the South Atlantic and certain other areas Wegener and his followers have also given good reasons for believing that continental masses, once continuous, have drifted apart.

Broad areas in southern Africa are built of rocks known as the Karroo Formation, of which the lower part, of late Carboniferous age, is characterised especially by species of the strange fern-like fossil plants Glossopteris and Gangamopteris. Associated with them are peculiar groups of fossil shells and fossil amphibia and reptiles. Similar rocks, with similar associations and contents, in Peninsular India have been named the Gondwana Formation. Comparable Formations also occupy large regions in Australia, Tasmania and New Zealand, in Madagascar, in the Falkland Islands and Brazil, and in Antarctica.

The correspondence between these areas is so close that Suess supposed they must at that date have been connected together by lands, now sunk beneath the sea, and he named the continent thus formed Gondwanaland after the Indian occurrences. The break-up of this land can be followed from a study of the rocks, and it was a slow process, its steps occupying much of Mesozoic time. Dr. A. L. du Toit's comparison of South African rocks with those of Brazil and elsewhere in South America favours even a closer union than this between the units now scattered.

One of the most remarkable features shown by these rocks in all the areas mentioned, but to varying extents, is the presence of conglomerates made of far-travelled boulders, scratched like those borne by the modern ice-sheets of Greenland and the Antarctic, associated with other deposits of a glacial nature, and often resting upon typical glaciated surfaces. There is no possible escape from the conclusion that these areas, now situated in or near the tropics, suffered an intense glaciation. This was not a case of mere alpine glaciers, for the land was of low relief and not far removed from sea-level, but of extensive ice-sheets on a far larger scale than the glaciation of the northern parts of the new and old worlds in the Pleistocene Ice Age. I have never seen any geological evidence more impressive or convincing than that displayed at Nooitgedacht, near Kimberley; while the illustrations and other evidence published by David and Howchin from Australia are equally striking.

Du Toit's work on these glacial deposits brings out two remarkable facts; first, that the movement of the ice was southerly, poleward and away from the equator, the

opposite to what would be expected, and to the direction of the Pleistocene ice-movement; secondly, that the ice in Natal invaded the land from what is now sea to the north-east.

When it is realised that at this period there is no evidence of glacial action in northern Europe or America, but a climate in which grew the vegetation that formed the coal seams of our Coal Measures, it is clear that we are not dealing with any general refrigeration of the globe, even if that would produce such widespread glaciation: we are face to face with a special glaciation of Gondwanaland.

On both sides of the Atlantic these glacial episodes in Carboniferous times were followed by dry and desert climates in Triassic time, and these by violent volcanic outbursts. Nor are the rocks alike only in mode of formation, the structures by which they are traversed correspond; while even in details there is remarkable agreement, as in the peculiar manganese deposits, and the occurrence of diamonds in 'pipes' of igneous rock, both east and west of the Ocean.

Rather than face the difficulties presented by the subsidence of lands connecting the severed portions of Gondwanaland, as pictured by Suess, Wegener has preferred, and in this he is supported by Du Toit and many other geologists, to bring into contact these severed parts, which could be fitted together as nearly as might be expected, considering the dates of severance. Du Toit's map of the period places South America to the west and south of South Africa, Madagascar and India to the east, Antarctica to the south, and Australia farther to the south-east. Such a grouping would form a continent much less wide in extent than that envisaged by Suess, and would offer some explanation of the more remarkable features of the glaciation in the several areas, as well as the problems of the rocks, fossils, and structures involved.

In its application to the geology of Gondwanaland the modified hypothesis of Wegener cuts a Gordian knot; but it still leaves a great climatal difficulty, unless we take his further step and conceive that at this date the terrestrial south pole was situated within Gondwanaland. No shift in the axis on which the earth rotates would, of course, be possible, nor is it postulated: only a drifting at that date of continental land across the pole.

If a hypothesis of drift be admitted for Gondwanaland, it would be illogical to deny its application to other regions, including the north Atlantic. I have already mentioned some facts in its favour. Others are the resemblances of all sedimentary rocks on the two sides from the Cambrian to the Ordovician, and from the Devonian to the Trias; the links between the structures of the land, as, for instance, between Ireland and Newfoundland; and the instance given by Professor Bailey in his address to Section C in 1928. As Bailey then pointed out, the great Caledonian range which crosses Scotland, northern England and Wales from north-east to south-west on its course from Scandinavia is affected and displaced by the east to west Armorican (Hercynian) chain extending across from Brittany to South Wales. 'The crossing of the chains, begun in the British Isles, is completed in New England'; and from here the Armorican structure continues its westerly course. This is where it should cross if the continent of North America were brought back across the Atlantic and placed in the position which, according to Wegener, it would fit into in the European coast! Can the Pilgrim Fathers have ever dreamed of such a link between the Old England and the New?

The hypothesis of continental drift gave rich promise of solving so many difficult problems that it was hailed by many classes of investigators almost as a panacea. Geographers have seen in it an explanation of the forms of continents and the position of peninsulas, islands and mountains; meteorologists have found it the solution of some of the problems of past climates and their anomalies of distribution over the world; biologists hope to get help with the intense complexities in the distribution of forms of life and many strange facts in migration, and palæontologists with similar difficulties among the ancient faunas and floras as revealed by their fossil remains; geodesists have welcomed escape from the rising and sinking of the crust, so difficult to reconcile with the demands of isostatic equilibrium; and it has been already stated that drift forms a vital factor in Joly's thermal cycles.

But there has been no lack of criticism in all these directions. It has been assailed on the one hand for the detail attempted in its geographical restorations, and on the other hand for its vagueness. Prof. Schuchert quotes Termier as saying that it is 'a beautiful dream, the dream of a great poet. One tries to embrace it, and finds that he has in

his arms but a little vapour or smoke: it is at the same time alluring and intangible.' It has been objected that 'no plausible explanation of the mechanics involved has been offered'; that the continental connexions postulated present by no means so close a match, when fitted together, as has been claimed, in the structure or the nature of either igneous or sedimentary rocks; that there is good evidence of extensive vertical movements in recent earthquakes, in the accumulation of tremendous thicknesses of sediment indicative of shallow-water from base to summit, and in the growth of coral reefs; that Central America and the Mediterranean are a difficult obstacle; and that the known distribution of the Karroo fossil reptiles is not by any means what the hypothesis demands.

If the idea of drift be accepted it cannot be regarded as a royal road out of all our difficulties, nor can it be the only form of earth-movement to be reckoned with. The late J. W. Gregory, whose life was sacrificed to geological discovery, has studied exhaustively the geological history of the Atlantic and Pacific Oceans, both as revealed by the sedimentary rocks and fossils on their borders, and by the distribution of life to-day. He finds that, according to our present knowledge, in the two oceans, facilities for migration have fluctuated from time to time, periods of great community of organisms alternating with periods of diversity. Again, at some times connexion seems to have been established north of the equator, at others to the south; and we cannot ignore the possibility of migration across polar lands or seas when terrestrial climates have differed from the present. The facts of life distribution are far too complex to be explained by any single period of connection followed by a definite breaking apart, even if that took place by stages. Mrs. Reid, too, has pointed out that resemblances between the Tertiary floras of America and Europe actually increased at the time when the Atlantic should have been widening. Unless continental drift has been a more complicated process than anyone has yet conceived, it seems impossible to escape from some form of the 'land bridges' of the older naturalists:

> 'Air-roads over islands lost—
> Ages since 'neath Ocean lost—'

We have no right to expect greater simplicity in the life of a planet than in that of an organism.

As the question of drift must in the last appeal be one of fact, it is not unnaturally expected that the real answer will come from measurements of longitude and latitude with greater exactness and over periods longer than has yet been possible. None of the measurements hitherto made has indicated variations greater than the limits of errors of observation. Two things, however, may militate against a definite answer from this source. Many parts of the crust, such as the shield-like masses of Archæan rock, may have completed their movement, or be now moving so slowly that the movement could not be measured. Careful selection of locality is essential, and at present we have little guidance. Also, as the displacement of crust must be dependent on the condition of its substratum, it will be a periodic phenomenon and the rate of movement may vary much in time. According to the theory of thermal cycles the subcrust is at present solid, and may not permit of drift. Drift, according to Joly and Holmes, is a cyclical phenomenon; if present-day observations were to give a negative result they would not necessarily disprove it.

The occurrence of recumbent rockfolds, and nearly horizontal slides or 'nappes' in mountain regions, gives positive proof that parts of the upper earth-crust have moved over the lower. In the North-west Highlands of Scotland a sliding of at least ten miles was proved by Peach and Horne, and in Scandinavia it amounts to sixty miles. For mountain packing as a whole the figures already given are far larger, while in Asia Argand has stated that packing of over 2,000 miles has occurred. Thus, when all is said and done, movements on a colossal scale are established facts, and the question of the future is how far we shall accept the scheme of drift due to Wegener, or one or other of the modifications of it. It is for us to watch and test all the data under our own observation, feeling sure that we shall have to adapt to our own case Galileo's words 'e pur si muove'.

Ever since it was realised that the inclination and folding of rocks must be attributed to lateral or tangential stress and not solely to uplift, shrinkage of the interior of the earth from its crust has been accepted as the prime mover, and whichever of the current theories we adopt we cannot deny the efficacy of so powerful a cause.

The general course of events in the formation of a mountain range is fairly well known;

the slow sinking of a downfold in the crust during long ages; the filling of this with sediment *pari passu* with the sinking, and associated softening of the sub-crust due to accumulated heat; the oncoming of lateral pressure causing wave-like folds in the sediments and the base on which they rest; the crushing of folds together till, like water waves, they bend over and break by overdriving from above or, it may be, underdriving from below; fracture of the compressed folds and the travelling forward for great distances of slivers or 'nappes' or rock, generally of small relative thickness but of great length and breadth, and sliding upon floors of crushed rock; the outpouring and intrusion of igneous rocks, lubricating contacts and complicating the loading of the sediments; metamorphism of many of the rocks by crystallisation at elevated temperatures and under stress, with the development of a new and elaborate system of planes of re-orientation and movement; and elevation of the whole, either independently or by thickening with compression and piling up to bring about a fresh equilibrium.

Such a course of events would be brought about by lateral pressure developed during the consolidation phase of each of the thermal or magmatic cycles. At each period of their building, mountains have arisen along lines of weakness in the crust, especially coast lines and the steep slopes marking the limits between continents and ocean basins. This is consistent with Joly's theory that the thrust of ocean beds against land margins is the cause.

But the advocates of continental drift point to the siting of ranges across the paths along which the drifting movement is supposed to have occurred, and they consider that the moving masses are responsible; and indeed that the ridging and packing of the crust has in the end checked and stopped the movement. They note that the great western ranges of America occur in the path of any western drift of that continent, the Himalayas in the course of the postulated movement of India, the East Indies in front of Australia; and that the Alpine ranges of Europe may be linked with the crushing of Africa towards the north.

The 'nappes' of rock, cut off from their origin and sliding for dozens of miles, are a constant source of wonder to all who have considered the mechanics of mountain formation. They are so thin as compared with their great length and breadth, that it seems impossible to imagine them moved by any force other than one which would make itself felt throughout their every particle. Such a force is gravitation, and it is of interest that some Alpine geologists and Dr. Harold Jeffreys have used it in explanation of them. Professor Daly has also adopted gravitation on an even greater scale in his theory of continental sliding: and one cannot fail to notice the increasing use of the term 'crust-creep' by those working on earth-movement.

Is there no other force, comparable in its method of action to gravitation, but capable of producing movement of the earth-crust in a direction other than downhill? Is it not possible, for instance, that the tidal influence of the moon and sun, which is producing so much distortion of the solid earth that the ocean tides are less than they would be otherwise, and, dragging always in one direction is slowing down the earth's rotation, may exert permanent distorting influence on the solid earth itself? May it not be that such a stress, if not sufficiently powerful to produce the greater displacements of continental drift and mountain-building, may yet take advantage of structures of weakness produced by other causes, and itself contribute to the formation of nappes and to other movements of a nature at present unexplained?

Our knowledge of geology has been gained by the survey of the rocks, the study of their structures, and the delineation of both upon maps and sections. This work is being accomplished by geologists all over the world, and this country and its dependencies have contributed their full share. It is therefore opportune to note that there has just been celebrated the Centenary of the Geological Survey of Britain and, with it, the opening of the new Geological Museum at South Kensington.

A century ago H. T. de la Beche, one of the devoted band of pioneer workers then studying the geology of the country, offered to 'affix geological colours to the new maps of Devon and Cornwall' then in course of issue by the Ordnance Survey. His offer was accepted, and, at his own expense and on his own feet, he carried out a geological survey of some 4,000 square miles. In 1835 he was appointed to continue this task, with a small salary and a few assistants. Thus was started the first official geological survey, an example widely followed by other nations

and dominions. De la Beche's conception included also a Museum of economic and practical geology, a Library, a Record of Mines, for which he secured support from a strong Committee of the British Association in 1838, and a School of Mines for the scientific and technical education of those to be employed in the survey or exploitation of mineral resources. In these objects, and especially the last, he was warmly supported by the Prince Consort. He lived to see his visions all come true, as he collected round himself that wonderful band of surveyors, investigators, writers and teachers, which included such men as Playfair, Logan, Ramsay, Aveline, Jukes, Forbes, Percy, Hooker and Huxley.

Some of the schemes he planned have budded off and grown into large and important entities, rendering conspicuous service to scientific record, education and research. But the main duties of the Geological Survey remained with it, and have been carried on for a century. These are to map the geology of the country on the largest practicable scale, to describe and interpret the structure of the land, to preserve the evidence on which conclusions have been founded, and to illustrate for students and other workers the geology of the country and its applications to economics and industry. The broad detail of the structure of the whole country is now known, but much new work must be done to keep abreast of or to lead geological thought. For instance, the study of the cloak of 'superficial deposits,' which often cover and conceal the structure of the more solid rocks below, is essential for the proper understanding of soils and agriculture; and a knowledge of the deep-seated geology of the country, which is often widely different from that nearer the surface and thus very difficult to interpret, is vital to the community for the successful location and working of coal and iron, and for tracing supplies of water and oil and other resources at depth.

Evolution of life on the earth has been by no means uniform; there have been periods of waxing and waning which may be attributed to geographical, climatological and biological influences. The development of large land areas, ranged longitudinally or latitudinally, the invasion of epicontinental seas, the isolation of mediterraneans or inland seas, the splitting of continental areas into archipelagoes or the reunion of islands into continuous land, the making of barriers by the rearing of mountain chains or the formation of straits or arms of the sea, the oncoming of desert or glacial climates; all such factors and many others have been of importance in quickening or checking competition, and in accelerating or retarding the evolution of life.

Probably, however, even greater effects have followed the interaction of groups of biological changes on one another. As an instance I might recall Starkie Gardner's estimate of the results following upon the first appearance of grasses in the world. This seems to have been not earlier than Eocene, and probably late Eocene times. By the Oligocene they had made good their hold, peculiarities in their growth and structure enabling them to compete with the other vegetation that then existed; and gradually they spread over huge areas of the earth's surface, formerly occupied by marsh, scrub and forest. They have, as Ruskin says, 'a very little strength....and a few delicate long lines meeting at a point... made, as it seems, only to be trodden on to-day, and to-morrow to be cast into the oven'; but, through their easy growth, their disregard of trampling and grazing, and by reason of the nourishment concentrated in their seeds, they provided an ideal and plentiful source of food. On their establishment we find that groups of animals, which had previously browsed on shrubs and trees, adopted them, with consequent alterations and adaptations in their teeth and other bodily structures. To follow their food from over-grazed or sun-scorched regions they required to be able to migrate easily and quickly, and it was essential for them to discard sedentary defence and to flee from threatened danger. Such defence as was possible with heels, teeth, or horns, they retained; but the dominant modifications in their organisation were in the direction of speed as their most vital need.

Side by side with this development, and in answer to increasing numbers, came bigger, stronger and speedier carnivores, to feed on prey now so much more abundant, but more difficult to catch. The answer of the grass-feeders, with their specialised hoofs, teeth and bones, better suited to flight than fight, was to seek safety in numbers, and thus develop the herd instinct, with its necessity for leadership and discipline; but this, in turn, provoked a like rejoinder from some types of their enemies.

When it is remembered how much of the

meat and drink and life of mankind is bound up with the grasses, including wheat, maize, millet and other grains, sugarcane, rice and bamboo, we must realise how close is his link with the development just outlined. Practically his whole food supply is provided by them, either directly by the agriculturist who grows little else but grasses, or indirectly by the herdsman whose domestic animals are fed chiefly on the same food. Nor must we forget that almost every one of our domesticated animals has been derived from the gregarious types just mentioned, which have accepted the leadership of man in place of that of their own species.

It is perhaps not too much to say that the magnificent outburst of energy put out by the earth in the erection of the Alps, Andes, and Himalayas in Tertiary times was trivial in its influence for man's advent and his successful occupation of the earth in comparison with the gentle but insidious growth of 'mere unconquerable grass' and its green carpet of 'wise turf' which in some form clothes by far the greater part of the land of the globe.

The kind of developmental reaction of which this is but a single example must clearly have had influence on bodily features, other than bones and horns, teeth and claws, speed and strength; and one of the most striking has been on intellectual development and the size and shape of brain.

We do not, and perhaps can never, know the quality of the material of which the brains of fossil creatures was made, for we have no instrument to pierce the veil of time as the spectroscope has penetrated the abysm of space. But we are even now learning something about their shapes and convolutions, and more about their mass in its relation to the size of the bodies controlled; from the time of the earliest Ordovician fishes, through the history of the amphibia, reptiles, birds and mammals up to man himself.

The brain of those gigantic if somewhat grotesque reptiles the dinosaurs, the tyrants of Mesozoic time, is relatively tiny. In Diplodocus, 80 feet in length and 20 tons in weight, the brain was about the size of a large hen's egg. It is true that there was a big supplementary sacral ganglion which may have taken chief charge of locomotion and helped to secure co-ordination throughout the hinder part of its huge length and bulk; but of true brain there was not more than a quarter of an ounce to control each ton of body and limb; and we begin to understand why they lost the lordship of creation.

The proportion of brain to body improved in those reptiles which took to flying, possibly in relation to their acquisition of warm blood, and in the birds evolved from reptiles; but it is only in mammals that a marked advance is seen. Here the brain of Uintatherium, a great rhinoceros-like animal of Eocene date, weighing 2 tons, was about the size of that of a dog. This proportion of half a pound of brain to each ton of body shows how far the mammals had gone, and still had to go.

A 12-stone man of the present day has about $3\frac{1}{4}$ pounds of brain—an amount not far short of half a hundredweight per ton.

Even though we can know nothing of its material, this steadfast growth in the guiding principle, through the millions of centuries that have gone to its development, is surely one of the most remarkable conclusions that we owe to geology. Of all the wonders of the universe of which we have present knowledge, from the electron to the atom, from the virus and bacillus to the oak and the elephant, from the tiniest meteor to the most magnificent nebula, surely there is nothing to surpass the brain of man. An instrument capable of controlling every thought and action of the human body, the most intricate and efficient piece of mechanism ever devised; of piercing the secrets and defining the laws of nature; of recording and recalling every adventure of the individual from his cradle to his grave; of inspiring or of ruling great masses of mankind; of producing all the gems of speech and song, of poetry and art, that adorn the world, all the thoughts of philosophy and all the triumphs of imagination and insight: it is indeed the greatest marvel of all.

And when we contemplate the time and energy, the sacrifice and devotion, that this evolution has cost, we must feel that we are still far from the end of this mighty purpose: that we can confidently look forward to the further advance which alone could justify the design and skill lavished on this great task throughout the golden ages that have gone.

Fig 1.

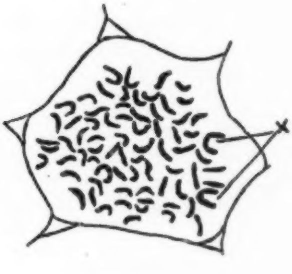


Fig 2.

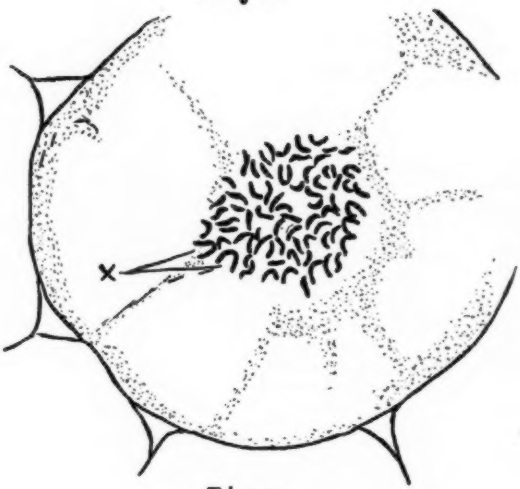


Fig 3.

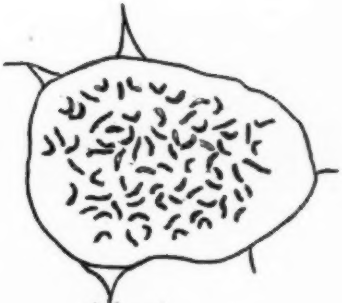


Fig 4.

Fig. 1. *H. sabdariffa* var Rubcr.
Fig. 2. *H. sabdariffa* Bhagalpuriensis.
Fig. 3. *H. sabdariffa* Altissima.
Fig. 4. *H. cannabinus.*
U-shaped chromosomes in figures 1 to 3 marked ×.

with another maximum division phase at 11 P.M. thereby showing a periodicity in mitosis. A number of somatic metaphase plates were counted in the two species and in each case the number was found to be 72 (Figs. 1 to 4). A preliminary examination of chromosome complements in the two species revealed certain morphological differences. The chromosomes were thicker and longer in *H. sabdariffa* than those in *H. cannabinus* and in the former species there was a greater number of U- and V-shaped chromosomes (Figs. 1 to 3) while in the latter there was greater number of rod-like chromosomes.

M. B. V. NARASINGA RAO.

Rice Research Station,
Berhampore,
September 4, 1935.

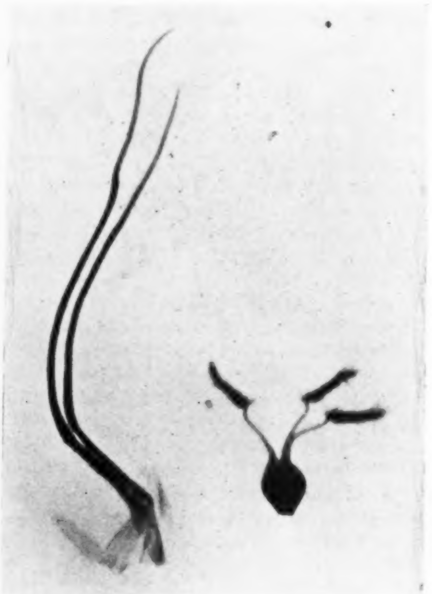
* This study was undertaken by the author while he was a post-graduate student at Pusa during 1930-32.

[1] Davie, *J. Genetics*, 1934, **28**, 33-67.

Further Data on the Homology of Stigmas and Awns.

IN a previous paper (G. N. Rangaswami Ayyangar and V. P. Rao, 1935)[1] the homology of stigmas and awns was dilated upon. In this note further data obtained is presented.

The first experience is from a very rare phenomenon in a family of sorghum in which the awns instead of being single, forked into two (Fig. 1). A careful examination of the stigmas was made with a view to look out for any possible repercussions of this forking of the awn. In one instance, three stigmas were noted (Fig. 1), with no aberrations in the ovary. According to Walker (1906)[2] in the tricarpellate pistils of *Andropogoneæ* two of the carpels normally form the bulk of the ovary and bear the style branches while the third carpel bears



Forked Awn. Forked Stigma.

Fig. 1.

the ovule. The photograph of the forked style is unmistakable in its import. Few and feeble as the response of the stigma has been, it is nevertheless significant.

The second evidence, derived from a cross between *Sufra*, a variety of sorghum from the Sudan and *Chinna Manjal Cholam*, a Coimbatore variety, is telling. In *Sufra*, which is awnless, the length of the stigma and style is unequal. *Chinna Manjal Cholam* has awns in which the column and the subule are of equal length. So also the stigmatic and stylar lengths. The F_1 was awnless and had styles and stigmas of equal length. In the second generation there was

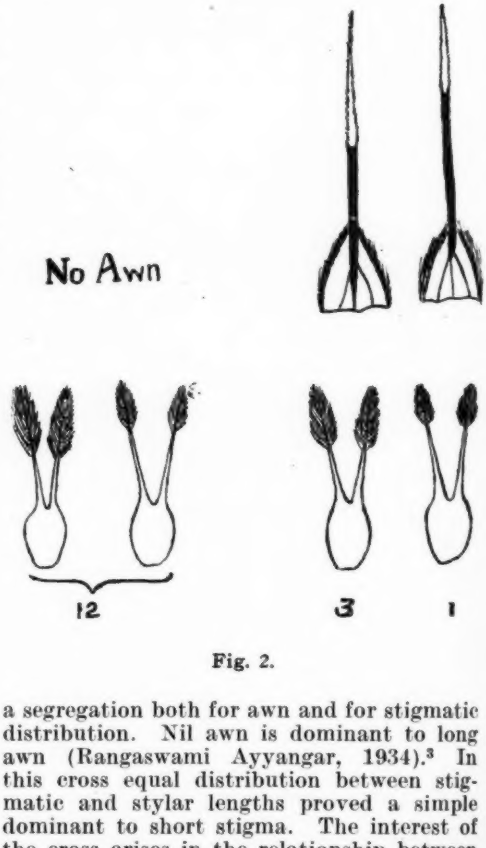


Fig. 2.

a segregation both for awn and for stigmatic distribution. Nil awn is dominant to long awn (Rangaswami Ayyangar, 1934).[3] In this cross equal distribution between stigmatic and stylar lengths proved a simple dominant to short stigma. The interest of the cross arises in the relationship between stigma and awns. The homology between stigmas and awns could not be pursued in the dominant awnless group which contained the two sets of stigmas. In the awned group also, there were both kinds of stigmas with this additional interest that being awned, equality and inequality of stigmatic surface kept parallel to the subular area of the awn (Fig. 2). A 12 : 3 : 1 ratio (actual figures 133, 33, 9) was obtained for the three groups, awnless, awned with equal lengths of subule and column and stigma

and style, and awned with unequal lengths of subule and column and stigma and style.

G. N. RANGASWAMI AYYANGAR.
V. PANDURANGA RAO.

Agricultural Research Institute,
Coimbatore,
September 6, 1935.

[1] *Curr. Sci.*, **1935, 3**, 540.
[2] *Univ. Nebraska Studies*, 1906, **6**, 203.
[3] *Madras Agric. J.*, 1934, **22**, 16.

Diurnal Insects Attracted to Light.

OUR knowledge of the activities at night of diurnal insects is still meagre, but among the butterflies, the Hesperiidæ, Pieridæ and Satyridæ are already known to occur at night. It is, therefore, interesting to record here for the first time the attraction to powerful artificial light of the Lycænid, *Zizeeria otis otis* F., which Dr. Rao recently collected in Aberdeen, Port Blair, South Andamans.

In this case all the seven specimens (4 ♂s and 3 ♀s) were attracted, along with other insects, to the light of an 'Aida' kerosene stormproof lantern in the bungalow between 7 and 8 P.M. on a single night last July. The bungalow is about a furlong from the foreshore of the sea and 60 feet above sea-level. The brilliancy of the light of the lantern is 350 candle power. The vegetation surrounding the bungalow consists of grass and low herbage interspersed with a few trees. The weather was not unusual for the particular time of the year, and there was no strong breeze blowing at the time.

From the literature available it is evident that the Lycænidæ are exclusively diurnal and fond of sunshine.[1] Seitz[2] comments upon their peculiar habit in tropical countries of disappearing almost at once when the sky becomes overcast with clouds. He also remarks that he has never seen any coming to the light of a lantern at night. This may perhaps have been due to the low intensity of the light. The fondness of *Z. otis otis* F., for bright light, therefore, proves it to be positively heliophilous. *Zizeeria otis otis* F., is a small low-flying butterfly which frequents grass, being found commonly wherever it occurs. The species is recorded from North India, Burma, Andamans, and Car and Central Nicobars.

I am grateful to Dr. H. S. Rao, Assistant Superintendent, Zoological Survey of India, Calcutta, for his notes on the nature of the environment, the weather and time of occurrence.

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Zoological Survey of India,
Indian Museum, Calcutta.
September 2, 1935.

[1] Dr. Rao informs me that he has observed on occasions these Lycænids hovering over the hedge-plants around the bungalow at mid-day.

[2] Seitz, A., *The Macro-Lepidoptera of the World* (*Indo-Australian Rhopalocera*), Lycænidæ, 1915, **9**, 799.

On Two New Halcampactid Actiniaria from Madras Brackish Waters.

THE Actiniaria inhabiting the brackish waters of Madras include two new acontiated Athenaria[1] belonging to the family Halcampactidæ,[2] showing relationships to *Pelocœtes exul* Annand. and *Phytocœtes gangeticus* Annand., described by the late Dr. Annandale from the Chilka Lake and the Gangetic delta.[3,4] In a note, Dr. H. S. Rao[5] records the occurrence of some brackish water Actinians at Madras; but as no detailed study was made, he did not commit himself to any definite view about systematic position.

The two anemones differ from all the other known Halcampactids and they will be described elsewhere as two new forms. Both the Actinians have long vermiform and fairly differentiated columns, and physa-like bases without basilar muscles. They are burrowing forms found living in the shallow mud flats on the fringes of the Adyar backwater. The distinction of the mesenteries into microcnemes and macrocnemes is perfect in both cases.[6]

The first is a long pink anemone characterised by a curious atypical arrangement of the tentacles and acontia. Here the tentacular arrangement is a deviation from that observed in typical Actiniaria, caused by an interchange of the two final cycles accompanied by an undue development of the tentacles of the fourth cycle, which by their abnormal position assume a false exocœlic appearance. Contrary to what is observed in other Actiniaria, each macrocneme of this anemone bears a very large number of acontia and the latter show very peculiar variations in regard to their

attachment to the macroenemes. An interesting correlation between the degree of development of the acontia and the probable order of succession of the macroenemes has been observed as a result of the examination of a large number of specimens.

The second form is a beautiful, orange-striped anemone with black marks at the bases of the tentacles. It is easily distinguished by the nature of the oral disc, the very prominent throat ridges which surround the mouth taking an active part in feeding. The plan of arrangement of the tentacles and acontia of this anemone does not present differences from that observed for typical Actinians. The single acontium occurring on each macroeneme is a long thick structure, which is often shot out through the cinclides.

The two anemones have more or less similar anatomical features, the differences being mainly concerned with the finer details. The nature of the base and column, the plan of mesenterial arrangement and the distribution of the nematocysts are essentially the same, and clearly show their close relationships and position in the same family. In both cases, the nematocysts of the acontia include both penicilli and spirulæ.[7]

Like other brackish water anemones known from the east coast of India,[3,4] these are permanent inhabitants of the brackish water and show several adaptations in correlation to their peculiar environs. The occurrence of a large number of parasitic (or commensal ?) Copepods in the cœlenteron of the specimens is noteworthy.

I wish to thank Professors R. Gopala Aiyar and T. A. Stephenson, for much valuable help and criticism.

N. KESAVA PANIKKAR.

University Zoological Laboratory,
Madras,
July 25, 1935.

[1] Carlgren, O., *Actiniaria, The Danish Ingolf Expedition*, 1921, **5**, pt. 9. 1-241.

[2] Carlgren, O., *Ark Zool.*, Stockholm, 1925, **Bd. 17 a**, 1-21.

[3] Annandale, N., *Rec. Ind. Mus.*, 1907, **1**, 47-74.

[4] Annandale, N., *Mem. Ind. Mus.*, 1915, **5**, 65-114.

[5] Rao, H. S., *Jour. Proc. As. Soc. Bengal*, 1925, **20**, No. 6, 339-347.

[6] Stephenson, T. A., *Quart. Jour. Micr. Sci.*, 1920, **64**, 425-574.

[7] *Jour. Mar. Biol. Assn., U. K.*, 1929, **16**, 173-200.

Sexual Dimorphism in the Indian House-Gecko, *Hemidactylus flaviviridis*, Rüppel.

WITH reference to sexual dimorphism in *Hemidactylus flaviviridis*, Rüppel, Baini Parshad[1] says: "The male is much smaller than the female and is much more active and agile, in build also it is much slighter and can be easily distinguished even from a distance." Lydekker,[2] on the other hand, says that "among geckos the males are generally larger".

An examination of more than three hundred preserved specimens and actual observations on live individuals do not confirm any one of these statements. The size appears to depend not on sex, but almost entirely on age and on the amount of food obtained by the individual. Quite a number of males in my collection measure 6–6·3 inches from snout to end of the original tail, the distance from snout to vent being in many cases 3 inches or more. This compares well with the maximum size recorded by Boulenger[3] for this species, "from snout to vent 3 inches; tail 3·2 inches;" and with that mentioned by Malcolm A. Smith,[4] "from snout to vent 90; tail 90 mm." I have also got a great many mature female specimens of this species which are far short of the maximum size.

As for activity, I have not been able to make out any difference between the two sexes. The gravid females probably are just a little less agile than the males, but we cannot be sure of this distinction.

It appears that the only reliable method of sex identification externally is to look for the femoral pores (present only in the male[5]) and for the postanal bones and sacs. The latter structures, first mentioned by Noble[6] and later by Malcolm A. Smith,[7] are peculiar to Geckonidæ. "The sac is present in both sexes, but the bone only in the male."[8] In the female *Hemidactylus*, the postanal sacs are much smaller and open by minute slit-like apertures generally within the posterior lip of the vent. In the male they are quite prominent and have their outer rims more or less protruded owing to the presence of a curved bone inside. As Smith[9] points out, the bone "can be recognised, after a little experience, without dissection by inserting the point of a needle into the opening of the sac and lifting the bone upwards."

Besides the foregoing differences, I might also point out (I hope for the first time in

this genus) a peculiarity of the male assumed during the breeding season, and that is the presence of two swellings on the ventral aspect of the base of the tail, separated by a slight longitudinal depression. The female has this area either flat or slightly concave. This distinction becomes prominent in March or April and shows signs of disappearing towards the close of the breeding season.

As far as I can ascertain, the only record about such swellings is by Annandale.[10] He, however, mentions it in *Gymnodactylus* and appears to have noted only one swelling, probably owing to the two males that he examined having suffered from over-long preservation. I am in a position to confirm his statement that the difference (at least in *Hemidactylus*) becomes prominent during the breeding season.

BENI CHARAN MAHENDRA.

St. John's College,
Agra,
July 30, 1935.

[1] Baini Parshad, "Some Observations on a Common House-Lizard (*Hemidactylus flaviviridis*, Rüppel) of India," *Journ. Bomb. Nat. Hist. Soc.*, **1916, 24, 834.**

[2] Lydekker, R., Cunningham, J. T., Boulenger, G. A., Thomson, J. A., "Reptiles, Amphibia, Fishes, and Lower Chordata," Methuen & Co., **1912**, p. **63.**

[3] Boulenger, G. A., "Fauna of British India (Reptilia and Batrachia)," **1890**, p. **92**, (*vide H. coctaei*).

[4] Smith, M. A., "Fauna of British India (Reptilia and Amphibia)," **1935**, **2**, **98.**

[5] *Ibid.*, **98.**

[6] Noble, G. K., "The Bony Structure and Phyletic Relations of *Sphærodactylus* and Allied Lacertilian Genera, with a Description of a New Genus," *Amer. Mus.*, Nov. **4**, **1921**, pp. **1-16**.

[7] Smith, M. A., "Fauna of British India (Reptilia and Amphibia)," **1935**, **2**, **25-26**; "Remarks on Some Old World Geckoes," *Rec. Ind. Mus.*, **1933**, **35**, **9-10.**

[8] *Op. cit.*, p. **9.**

[9] Smith, M. A., "Fauna of British India (Reptilia and Amphibia)," **1935**, **2**, **25-26.**

[10] Annandale, N., "New and Interesting Lizards in the Colombo Museum," *Spolia zeylonica*, Jan. **1906**, **3**, Part **11.**

The Quartzites of the Bababudan Area, Kadur District.

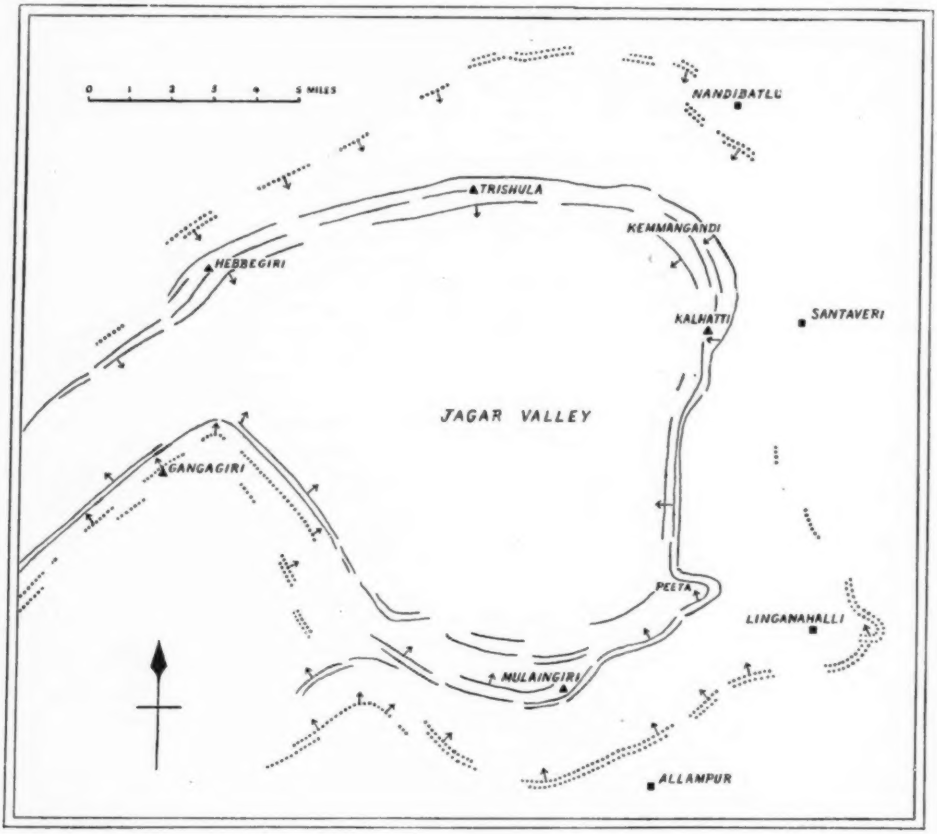
IN referring to the quartzites occurring in the Mysore State, Dr. W. F. Smeeth, one of the former Directors of the Mysore Geological Department, has stated : "There can be little doubt that many of the quartzites are crushed and recrystallised quartz-veins and quartz porphyries, and possibly felsites, and it is at least open to question whether we have any which are genuine sedimentary rocks."[1] In the course of a recent examination of the quartzites occurring in the neighbourhood of the Bababudan ranges, the writer obtained certain evidences which indicate that these quartzites are sedimentary rocks of the nature of sandstones.

The quartzites are generally white in colour, but often they are of various shades of brown. Sometimes they are green, this colour being due to the presence of a green mica. The texture is saccharoidal. The rocks are ordinarily compact but weathered specimens crumble into a granular sand. Under the microscope, the individual grains are often set off by the matrix which is sometimes ferruginous. The grains are not quite uniform in size. In highly crushed varieties, porphyroclasts of quartz occur in a matrix composed of minute grains of quartz, mica and iron ore.

There are several runs of quartzites in the area and brief descriptions of those occurring south of Allampur are given by Bruce Foote,[2] Sampat Iyengar[3] and Balaji Rao.[4] Sampat Iyengar considered that these quartzites were formed by the crushing of quartz reefs.

The runs of quartzite are remarkable in that they follow both in the directions of strike and dip, the banded ferruginous quartzites of the Bababudan ranges, which have been considered by the writer for reasons given elsewhere,[5] to be sedimentary deposits. Fig. 1 is a sketch map giving the main trend lines and directions of dip of the banded ferruginous quartzites, as well as those of the nearest quartzites. It will be seen from this map, that in spite of the discontinuity of the quartzite runs here and there, there is a general parallelism to the banded ferruginous quartzites which have a more or less ring-shaped outline. This agreement in trend is brought out very clearly by the bend in the quartzites near Linganahalli, which closely corresponds to the kink which is noticed in the ferruginous quartzites near the Peeta in the Bababudans.

The quartzites south of Allampur and immediately to the north of Chikmagalur are pebbly in character. The pebbles vary in size from a fraction of an inch to nearly



(Adapted from the map of Slater and Sampat Iyengar, *Recs. Mys. Geol. Dept.*, Vol. 9.)

Fig. 1.

Sketch map of the Bababudan area showing the parallelism in strike between the banded ferruginous quartzites and the adjoining quartzites. The arrows indicate directions of dip.

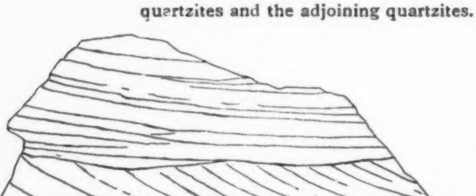


Fig. 2.

Sketch of a hand specimen of quartzite showing cross-bedding.

six inches across. Sampat Iyengar was of the opinion that these rocks were "pseudo-conglomerates," though he has admitted that the rounding of the quartz is so perfect that it could be very easily mistaken for a sandstone. In support of his view, he states: "Two or three of the rounded pebbles have undergone further crushing into smaller pieces so that, at present, the rock section ($Z_3$661) has assumed the form of a quartzite conglomerate. But the simultaneous extinction under the microscope of three or four rounded pebbles of quartz in close contiguity, give the clue to the crushed nature of the large pieces of quartz."[6] The writer fails to understand how, after pressure

had acted on the pebbles and *rounded* them, they could still preserve their original crystallographic orientation.

The most remarkable feature noticed by the writer in the quartzites is the occurrence of cross-bedding. Very good specimens were collected from the quartzites north of Allampur. Fig. 2 is a sketch of one of the specimens. The bedding planes are seen because of the deposition of ferruginous material along them.

The writer is of opinion that the facts of observation detailed in this note, definitely suggest that the quartzites of the Bababudan area are not of vein origin but are ordinary sedimentary arenaceous rocks.

CHARLES S. PICHAMUTHU.
Department of Geology,
Central College,
Bangalore,
August 26, 1935.

[1] Smeeth, W. F., *Mys. Geol. Dept. Bulletin*, 1916, **6**, 10.
[2] Bruce Foote R., *Mem. Mys. Geol. Dept.*, 1900, **1**, 37.
[3] Sampat Iyengar, *Rec. Mys. Geol Dept.*, 1908, **9**, 71-72.
[4] Balaji Rao, B., *Rec. Mys. Geol. Dept.*, 1913, **13**, 139-141.
[5] Pichamuthu, C. S., *Curr. Sci.*, 1935, **3**, 606-608.
[6] Sampat Iyengar, P., *op. cit.*, 72.

*Obituary.

Lieut.-Colonel H. W. Acton, C.I.E., I.M.S.

WITH the death of Lieut.-Colonel Hugh W. Acton, C.I.E., I.M.S., there terminates a very brilliant career of medical research work in India, and one of great benefit to this country.

Colonel Acton was a medical student of Middlesex Hospital, London, and before qualifying had carried out special research work on tumours under Sir John Bland Sutton. He entered the Indian Medical Service in 1907, and his first few years in India were spent in military duty,—chiefly on the north-west frontier. Here he made the important discovery that enteric fevers, which at that time were supposed to be of exceptional rarity among Indians, were actually not uncommon in Indian troops.

In 1910 he was posted to the Pasteur Institute of India, Kasauli, as Assistant Director under Lt.-Colonel W. F. Harvey, I.M.S. At that time antirabic treatment in India was in a rather unsatisfactory state. From 1900 to 1907 the Kasauli Institute had used Pasteur's original "dried cord" method, but this was unsatisfactory on account of sepsis and of the introduction into possibly susceptible persons of a large amount of nerve substance, which might lead to "neuroparalytic" accidents. From 1908 to 1911 the dilution method of Högyes was employed ; this was free from sepsis, and the amount of nerve substance injected was minimal, but theoretically at least, the use throughout the course of immunisation of a living rabies virus was not free from risk. Sir David Semple had suggested the use of a (dead) carbolised vaccine, and the years 1910 and 1911 at Kasauli were spent by Colonels Harvey and Acton in testing this out experimentally. Monkeys (*Silenus* or *Macacus rhesus* species) were used in very large numbers ; these had to be first inoculated with rabies "street virus" and then to be inoculated with the carbolised vaccine, and the experiments were carried out at very considerable personal risk to the workers concerned. The result of this work was the introduction in 1912 of Semple's carbolised vaccine, which is to-day in use throughout the Pasteur Institutes of India, and the present efficacy and smooth running of antirabic treatment throughout India is very largely due to the work of Colonels Harvey and Acton. Many years later Colonel Acton suggested the use of sheep instead of rabbits for the "fixed virus", thus again improving results. Whilst these experiments were in progress a "fixed virus" strain was established in the *Macacus rhesus* monkey and it was shown that the Negri body of rabies is of the nature of a cell-inclusion, this work anticipating by many years much of our present-day knowledge of the filterable viruses.

Between 1912 and 1914 Colonel Acton carried out other very important research work at Kasauli. This dealt with latent malaria in dog-bite patients, among whom the sudden change to the cold and altitude of a hill station may often precipitate a relapse of malaria ; with *Hæmoprojeus* infection in pigeons ; with the process of acclimatisation to a hill station altitude and a study of the blood changes concerned. Very important were his studies of snake bite in India. These occupied three years

and were carried out in a very systematic manner. Thousands of experimental animals were utilized—chiefly rats; and some three hundred or more poisonous snakes, the latter being caught by four gangs of professional snake catchers in the Bihar jungles. The chief results of this enquiry were to define with some approach to accuracy the doses injected by the different species of snakes concerned, the relative toxicity of the different venoms, the use of gold chloride as a neutralising reagent, and the necessity for a highly concentrated antivenene. A good resume of the whole subject is given by Colonel Acton in Vol. I of Byam and Archibald's *Practice of Medicine in the Tropics*.

After the outbreak of War in 1914, Colonel Acton was transferred to Simla, as Medical Officer of Health, and subsequently went to Mesopotamia as pathologist and surgical specialist to No. 12, Indian General Hospital at Amara. Here he studied especially the subject of oriental sore, and discovered that the distribution of oriental sores and of sandfly bites on the surface of the body is identical. An important memoir on the subject was published in 1919 and led to the incrimination of *Phlebotomus argentipes* as the vector in India of kala-azar, and of *P. papatasi* and *P. sergenti* as the vectors of oriental sore in north Africa, Palestine and Mesopotamia.

On his return from Mesopotamia, Colonel Acton was posted to the Malaria Convalescent Depôt at Dagshai. This afforded him a unique opportunity for research work on the treatment of malaria. British troops from the different war zones and from all over India were sent to Dagshai in the Simla hills to recuperate. The altitude and the absence of mosquitoes here excluded the possibilities of re-infection, and hence any attack of malaria which occurred was *ipso facto* one of relapse. In a short series of papers Colonel Acton and his colleagues at Dagshai showed: (*a*) that *Plasmodium vivax* is essentially the parasite associated with relapsing malaria; (*b*) that the alkaloids other than quinine in cinchona bark are almost, if not equally as efficacious in the treatment of malaria, so that the very much cheaper treatment with cinchona febrifuge may replace the more expensive quinine treatment; and (*c*) that administration of alkalies greatly enhances the value of the cinchona treatment of malaria. Later Colonel Acton proceeded on deputation to England, where he worked under Sir Henry Dale, at the National Institute for Medical Research at Hampstead on the action of the different cinchona alkaloids on free-living protozoa: the results of this enquiry were to confirm his previous work on the equal efficiency of the different cinchona alkaloids.

In 1921 Colonel Acton became Professor of Pathology, Bacteriology and Helminthology at the Calcutta School of Tropical Medicine, and held this appointment until April 1933. In this appointment he carried out a very large volume of medical research work of a very high order. His work on epidemic dropsy, for example, aroused widespread interest. He showed that the disease was almost always associated with the eating of diseased rice; that rice stored in damp godowns readily became infected with bacilli of the *vulgatus* group; this might cause the formation of soluble toxins in the rice, and when such rice was eaten the absorption of these toxins might cause the symptoms of epidemic dropsy. In very rare instances the patient might acquire an intestinal infection with these organisms, and his stools become infectious to other persons.

Other work, carried out in collaboration with Colonel Chopra, dealt with the toxins of the cholera vibrio;–a subject which is only to-day receiving the close attention which it deserves.

His work in collaboration with Dr. S. Sundar Rao on filariasis was a most notable contribution to tropical medicine. So many and varied are the manifestations of filariasis due to *Wuchereria bancrofti* that at one time the idea was raised that there might be more than one species of worm concerned in India. This view Acton and Sundar Rao showed to be wrong. In heavily endemic areas, such as the Malabar coast, transmission is possible practically the whole year round, the population is constantly being injected with large doses of developing filarial embryos, the superficial lymphatics readily become blocked, and, as a result, elephantiasis is the commonest manifestation of the disease. In slightly endemic areas, such as Calcutta, transmission is only possible for some three months or so of the year; the population receive only small and occasional doses of developing embryos; these are able to make their way rapidly to the deep lymphatics of the pelvis, and in such areas the chief manifestations of the disease are filarial fever,

lymphangitis, chylocele and hydrocele. The lymphatic glands may be blocked in one of two ways; either the worm may die in the gland and obstruct the flow of lymph; or it may cause irritation and inflammation of the gland as it passes through, and super-added sepsis from septic focus anywhere in the body may lead to acute inflammation. Thus the treatment of filariasis resolves itself into the careful examination of the patient for any source of focal sepsis which must be dealt with; the use of autogenous vaccines; and care of the general health. It is not likely that any drug will be discovered which, after injection, will reach the deep lymphatics of the pelvis where the mature worms are lying in sufficient concentration to kill them.

Other research work conducted by Colonel Acton at the Calcutta School of Tropical Medicine dealt with the dysenteries of India: in common with many other workers he found that the incidence of bacillary dysentery in the tropics is very much higher than that of amœbic dysentery. His outstanding contribution to tropical medicine, however, was his study of the skin diseases of the tropics. In 1921 when he commenced his special studies in this subject, it was one of very great confusion. The clinician was describing an ever-increasing variety of new syndromes under new names, whilst the pathologist was constantly discovering new fungi affecting the skin. The great merit of Colonel Acton's work in this subject was that he always searched for the true underlying ætiological agent. Thus a "weeping eczema" of the leg may be due to a streptococcal infection superimposed on a ringworm infection. The best line of treatment for such a condition is not to use irritants; but to use at first soothing applications; then perhaps an autogenous streptococcal vaccine to eliminate the streptococcal infection; then, when the secondary infection has been cleared up, the primary ringworm infection may be dealt with by more drastic remedies.

Colonel Acton's contributions to the subject of "tropical dermatology" were many, and all of them are of importance. He came to occupy almost the (honorary) post of consulting dermatologist to the whole of India. The numbers attending the clinic rose to 12,000 a year. Not only that, he also trained his assistants in methods and technique, and has left as a legacy to the School the only department of medical mycology in India.

Colonel Acton became Director of the Calcutta School of Tropical Medicine in July, 1928. In that appointment he showed not only his genius as a research worker, but his admirable capacity for directing and co-ordinating the work of others. He had an ability to get at the essentials of a research problem, to map out proposed lines of investigation, to suggest technique and procedure, and to assess results, characteristic of genius of a very high order. To-day there is not a department in the School which does not owe a deep debt of gratitude to his powers of organisation and administration.

India will long treasure his memory, for he was the most brilliant of a band of research workers in the Indian Medical Service which is rapidly dwindling in numbers. His life-work will serve as an example to the coming generation, for he gave his best to India with a selfless and devoted generosity.

R. KNOWLES.

Prof. Dr. Emmy Noether.

IN the death of Emmy Noether on 14th April 1935 as the result of an operation, the mathematical world loses one of the foremost investigators in the domain of modern Algebra and an unique and characteristic personality. She was born on 23rd March 1882 as the daughter of the mathematician Max. Noether.

Remarkable as her work was when due consideration is paid to her sex, it is still more remarkable as a contribution to the methods of mathematical thought which she employed in all her work. She was a great apostle of abstract thought and considered no theorem elegant and no proof complete until the inner abstract spirit underlying the ideas was laid bare. She never thought in terms of formulæ but only in concepts and therein lay her great strength. The guiding principle which she actually applied to her work was that no relations between numbers, functions and operations could be considered significant, capable of generalisation and useful unless they were detached from special environments and related to abstract conceptual notions.

It was in the domain of Algebra and Arithmetic that she worked most. She used and enriched the concepts of fields, ideals, modulus and isomorphism by a generalisation of Dedekinds "Modultheorie". Her doctorate dissertation (1907) concerned itself with Gordan's invariant theory in n-ary domain. She soon came under the spell of Hilbert's ideas and did fundamental work in connection with the finiteness theorem and the problem of construction of equations with specified groups.

Emmy Noether can truly be described as the greatest woman mathematician who has done work of such high excellence in the region of abstract mathematical thought. B. S. M.

Magneto-Chemistry.*

IN recent years there has been a great revival of interest in magneto-chemistry, and an extensive series of experimental investigations have been carried out, stimulated by the fact that there is now a sufficient background of adequate theory to enable the significance of the results obtained to be more clearly appreciated. One of the most active workers in the field has been Prof. Bhatnagar, who, with his collaborators at Lahore, has contributed extensively to the progress that has been made.

Although a number of good books have been written on various aspects of magnetism in the last few years, none has been written by a chemist. In the study of the more complex compounds, whether inorganic or organic, a thorough knowledge of the chemical outlook on questions of constitution is necessary in order that the salient points of interest in the results may be brought to light. Prof. Bhatnagar is well fitted to deal with such questions. Further he can approach the general treatment of magnetism with a due appreciation of the kind of presentation which will be of most value to chemists who previously have not studied the more physical and mathematical aspects of the subject. The aim of this book is to place before chemists a comprehensive and at the same time comprehensible account of the experimental and theoretical researches which have been carried out in this field. The authors have been extremely successful in achieving this aim.

Of necessity, if the book was to be a more or less complete whole rather than a chemical supplement, previous books have been freely drawn upon, as is fully and gracefully acknowledged. It is unnecessary to review in detail such parts of the book as present anew such matters as have been dealt with elsewhere. It is sufficient to say that the matter has been well selected, and that in the presentation further points of cognate interest are often noticed, and that where necessary more complete tables of data are given. In indicating the scope of the book, special attention will be directed to those parts which deal more particularly with matters which have not previously been dealt with in detail in book form.

* "Physical Principles and Applications of Magneto-Chemistry." By S. S. Bhatnagar and K. N. Mathur. Pp. xiv + 375. (Macmillan & Co., London, 1935.)

The book opens with a pleasantly written historical introduction, in which mention is made of a reference to the lodestone in the Vedas, and, to skip over intervening millenniums, an appreciative account is given of such earlier theories of magnetism as those of Poisson, Weber and Ewing. The fundamental ideas and definitions are introduced, and an account is given of the usual methods of producing magnetic fields, the large Paris electro-magnet being also described. A brief account of methods of measuring fields follows, particular attention being paid to the convenient fluxmeter method. The theory of susceptibility measurements is given in a sound, if not quite the simplest, form, and a very full account follows of the various types of magnetic balance, including several which are due to Bhatnagar and his pupils. This is probably the fullest account of magnetic balances which has been given, and will provide the intending investigator with a wide choice.

The work of Curie, Honda and Owen, and Pascal is then described under the heading "Pan-Magnetism of Matter". The account of Pascal's work, which, it seems to the reviewer, is seldom sufficiently appreciated, is very detailed and contains a most valuable set of tables of data.

An account is then given of the theory of spectra and atomic structure, based on the original Bohr theory, and the vector model of the atom. It is wise of the authors not to overload their book by entering more fully into the intricacies of quantum mechanics, for the account given here will probably be quite adequate for the chemical experimentalist.

Dia- and para-magnetism are treated in turn: an adequate indication is given of the quantum-mechanical treatment of Van Vleck, and also of the theory of the paramagnetism of free electrons. The account of ferromagnetism is very brief, but it is sufficient to draw attention to the complexities of the problems involved, which fall rather outside the central chemical field.

Magnetism and valency are then considered, the sequence of ideas due to Werner, Kossel, Lewis, Heitler and London, Sidgwick and Pauling being traced. Ionic paramagnetism is taken up again, and here there is some overlapping, but it is not serious, as the questions are discussed from

new points of view, and complex compounds are also considered.

In a chapter on magneto-optics, the Faraday, Cotton-Mouton, Kerr and photomagnetic effects are discussed. Here of particular value is the detailed account given of the magneto optical researches of Perkin, which parallel those of Pascal, and have been too often overlooked.

A summarizing account of the various magneto-mechanical and galvano-magnetic effects occupies the twelfth chapter, which is followed by a chapter on magneto-crystallic action, which is brought well up-to-date. The interesting question of the influence of magnetic fields on chemical reactions is then discussed, and in the final chapter some miscellaneous applications of the use of magnetic properties in physico-chemical investigations are described.

In an epilogue attention is directed to some outstanding problems, such as those connected with the magnetic properties of compounds of transition elements other than those of the iron and rare earth group and the interpretation of the significance of the Pascal constitutive factors, and to the need for more precise measurements of a large number of substances. An appendix includes a useful list of susceptibility values.

It will be clear that the book covers the field in an extremely comprehensive manner. It will be readily comprehensible, and the extensive information it gives, the numerous tables of data, and the lists of references will undoubtedly be of great value, particularly to chemists, not only in showing what has been done, but also in indicating lines of investigation which should be followed up. Prof. Bhatnagar and Dr. Mathur are to be congratulated on having brought to completion so successfully a book which clearly entailed an enormous amount of painstaking work, and so making available to others a detailed survey of the investigations which have been carried out in this wide field.

It remains to add that the book is well-indexed and excellently produced. It is a most useful addition to the literature of magnetism.

EDMOND C. STONER.

The Structure of Molecules.*

THE latest volume of the collection of works on modern molecular physics, which was edited by Born and Franck, is a book of Dr. H. A. Stuart: *Molekülstruktur*. Like all the other volumes of this series it is meant primarily for the research worker, interested in similar lines. Although a brief account of the wave-mechanical theory of valency and band spectroscopical determinations of the energy of dissociation have been given in the first and last chapters, the main interest of the monograph is not concerned with the electronic configurations of the molecules, but centres round the questions of the arrangements of the nuclei. Here, however, in a branch of knowledge to which the author has contributed to a large extent, particularly by measurements of the Kerr effect, the publication is an extremely reliable and useful guide. In the second chapter the older methods to determine the constants of a molecule are described, such as arise from kinetic theory. A chapter on direct measurements of internuclear distances and valency angles by X-ray spectra and electron interferences, is followed up by a more theoretical presentation on the inner-molecular potential, free rotation and related questions.

The three following chapters particularly will interest most of the readers. The first of them deals with electric polarisation and dipole moment of the molecules and with the structure of the molecules as revealed by the approximately constant moments of the groups. Then follows a chapter on the depolarisation of Tyndall and Raman radiations and the electric Kerr effect which is particularly valuable in determining the anisotropy of the polarisability of a molecule and finally a chapter on infra-red and Raman spectra, by which the vibration frequencies of the nuclei are determined.

In order to see, how these different methods to determine the nuclear structure of a molecule supplement each other, we will consider the results obtained for nitrous oxide, the structure and formula of which were uncertain for a long time. The mere existence of the Raman spectrum excludes from the beginning any electrovalent formula. The Kerr effect excludes a formula

* *Molekülstruktur*, by H. A. Stuart (Verlag von Julius Springer). Pp. 388. Price RM. 33·80.

like  and, since the dipole moment is small but certainly different from 0, a symmetrical formula like N—O—N is not possible. Indeed, infra-red and Raman spectra are in best agreement with the unsymmetric linear formula N ≡ N = O, which is confirmed by experiments on electronic interference in N_2O which also indicate a distance of 2·38 A.U. between O and the farther N atom.

This one example may be sufficient to show that it is rarely possible to determine the structure of a molecule by only one experimental method, which describes and seizes only one of its properties, but that all of them have to be taken into account. Dr. Stuart's monograph will be extremely useful to all those who want to compare their own results with those obtained by others by different methods.

R. SAMUEL.

Electro-kinetic Phenomena.*

THE Board of Editors of "The American Chemical Society Monographs" has two objects in view in publishing their excellent series: first, to present the knowledge available upon a chosen topic in a readable form, intelligible to those whose activities may be along a wholly different line and secondly, to promote research in the branch of science covered by the monograph, by furnishing a well-digested survey of the progress already achieved in that field and by indicating fruitful lines along which the investigation might be extended. That both these commendable objects have been achieved in a special degree will be realised by every reader of the monograph on Electrokinetic Phenomena, which presents for the first time important literature scattered through various journals in a connected form.

The phenomenon has been treated from a definitely biological standpoint. The volume includes discussions on organic compounds, blood cells, soils and inorganic materials, and a separate chapter has been devoted to the special aspects of electrokinetic phenomena relating to proteins. Problems connected with the fractionation of proteins from their mixtures are indicated in the section on mixtures of proteins. The applications of this phenomenon in the field of biology and medicine are indicated particularly in the Chapters X and XI which deal with blood-cells, tissues, spermatozoa, bacteria, antibodies, viruses, etc. The selective permeability of living membranes in relation to the electrostatic forces obtaining in the pores of the membrane, which is discussed in the volume, has a close bearing on the introduction, locally, of drugs, the molecules of which are charged.

The fact that isospermatoxins produce loss of sperm motility, leads to the possibility of determining quantitatively the period of immunisation against pregnancy. The influence of such precise physico-chemical control of contraceptive technique should be of more than usual significance. The above two examples of the application of the electrokinetic phenomena, culled out at random from the book, is illustrative of the wide appeal which the volume is entitled to have. The book is written in a style and manner which render it not only exceedingly informative but also most stimulating.

M. S.

* '*Electrokinetic Phenomena*.' By Harold A. Abramson. American Chemical Society Monograph Series No. 66. (The Chemical Catalogue Company Inc., New York.) 1934, pp. 331.

Chronica Botanica.*

FR. VERDOORN has done a great service to the Science of Botany in bringing out *Chronica Botanica*, a useful book of 447 pages. This is mainly a book of information on the progress of Botany in all its aspects pure as well as applied and the author wants to publish it every year. Its success will depend upon the co-operation of the Botanists all over the world.

The book opens with a letter from E. D. Merrill of the New York Botanical Gardens. There is a timely pleading for the International Co-operation among the Botanists. When the spirit of narrow nationalism is running so high it is very gratifying to read this letter. International co-operation has been successfully achieved by Botanists. The plants have no narrow political boundaries. The real co-operation began with the Taxonomists.

In the Almanac for the year 1935 useful information is given of outstanding anniversaries, meetings of International Congresses and Jubilees of various Botanical Institutions.

The detailed programme of the Sixth International Botanical Congress in Amsterdam, 1935, and its Officers occupies nearly ten pages. In the middle of this, a page is set apart for the portraits of eminent Botanists who passed away since the fifth Congress. It is curious that D. H. Scott, the premier paleobotanist, does not find a place here. A special note has been added about John Briquet (1870–1931), a great Taxonomist who rendered invaluable service to Taxonomy and to the success of the International Botanical Congress.

A lucidly written article by A. B. Rendle, F.R.S., on the history of the International Botanical Congress from 1864 to the end of 1930, when the Congress met in Cambridge is of great value for all students of Botany. He shows how the earlier congresses had combined both Horticulture and pure Botany for discussion. From 1900, when the Congress met at Paris the pure Science is having a separate Congress. The second and third Congresses were held in Vienna (1905) and Brussels (1910). Owing to the great catastrophe of 1914–18 the Congress could not meet in London in 1915 and the aftermath of this lasted till 1926 when the Congress met at Ithaca, New York. The 1930 session at Cambridge with Prof. A. C. Seward as President, was a great success and it may be said that the Congress has become a normal annual event.

This is followed by accounts of various International Congresses, Committees and Societies. Useful information for those that are engaged in special fields could be gathered from these. Unfortunately no mention has been made of the Indian Science Congress here.

The succeeding chapter on a Review of all branches of Plant Science during 1934 which occupies the bulk of this publication covers 258 pages. The progress of the Science and personal news are treated in all countries in the alphabetical order, commencing from Afghanistan and ending with Zanzibar. The accounts of persons and matters are of real value. In spite of the earnest appeal from the author, the response has not been adequate. While the technical departments have given useful accounts of the institutions, the Universities have not manifested their co-operation. In India seven out of the seventeen Universities have sent meagre information. It is necessary that all the institutions should send as far as possible a fuller account of their equipment and the investigations carried on or are in progress.

This annual register does not seem to be the proper place for correspondence, however useful the letters may be.

The last 103 pages cover the new and changed addresses of persons, classified advertisements of posts, book-sellers and periodicals. Even the laboratory suppliers find their place here.

A short illustrated History of Botany in the Netherlands has its humourous side.

The book should find a place in every Botanical Institution.

M. A. SAMPATHKUMARAN.

* *Chronica Botanica*, edited by Fr. Verdoorn, Leiden Netherlands, 1935, pp. 447, 15 Neterl. guilders.

Reptilia and Amphibia of British India.*

THE present volume is the second of the four into which Dr. Smith planned to divide the revision of the Reptilian and Amphibian Fauna of British India. The first volume, dealing with the *Loricata* (Crocodilia) and *Testudines* (Chelonia), appeared in March, 1931. The third volume will deal with the Snakes, and the fourth with the Amphibians. Both the volumes so far published mark a decided improvement over Boulenger's work "Reptilia and Batrachia" 1890, in this series.

As mentioned by the author in his preface to the First Volume, the region dealt with is not precisely that forming the scope of Boulenger's work, but "has been extended to include the whole of the Indo-Chinese sub-region, and is almost the same area as that included by Günther in his "Reptiles of British India," 1864. This extension in the limits of the area dealt with is due to the fact that the fauna of Siam, French Indo-China and Southern China is so closely allied to that of Burma that the author feels it to be scientifically incorrect to separate the two from each other. We trust that the change is for the better, as it makes it possible to avoid the artificial division of this natural sub-region and to consider it as a *whole*. Altogether, the volume on *Sauria* (Lizards) describes 297 species, of which 248 occur in the Indian Empire; while Boulenger's work (1890) contained descriptions of 226 species of Lizards (including also the Chamæleon), of which 17 were "included upon incorrect data or have since been placed as synonyms". This means that Dr. Smith's volume contains the descriptions of 39 more species than Boulenger's.

As in his descriptions of the orders *Loricata* and *Testudines* in the First Volume, the author begins his work on *Sauria* with an illuminating general Introduction, which deals with Structure, Evolution, Devolution, Geographical Distribution, Economics, and Preservation and Examination of Specimens. Dr. Smith possesses the knack of clear and concise expression and he has, in this Introduction, condensed a great deal of scientific knowledge about this group of reptiles. In the section on Evolution and Devolution, he gives a valuable account of the evolution of the adhesive digital pad and the external coverings of the eye, as also of the degeneration of the eye, the ear and the limbs. The remarks in this section, as pointed out in the preface, are the "outcome of the study of the structure of the Indian and Indo-Chinese species". But the author assures us (pp. v, vi) that he has carried out his researches much further afield and has studied the wholegroup from this standpoint. We look forward eagerly to a fuller account of these problems.

About *femoral glands or organs* (p. 4), the author says, "They are not true glands, but tubular invaginations of the epithelium, the opening of which, termed the pore, may perforate a scale or lie between two or more scales." We are not in a position either to endorse or to refute the author's verdict that these are not really glands; but certainly there are a great many workers who have investigated these structures and are inclined to regard them as glands. Camp (1923)[1] gives an excellent résumé of the work done in this direction, and says: "Duvernoy, Wagler (1830),[2] and Johannes Muller first noted the glandular nature of the femoral organs. The histology has been investigated by Leydig (1872), Schæfer (1902),[3] Cohn (1904),[4] Tölg (1903),[5] Félizet (1911)[6] and others. Félizet remarks upon the similarities with the mammalian sebaceous gland....... This was also partly the view of Meissner (1832),[7] Leydig, and Schæfer, and many later workers....... Maurer....believed that the proximity of lymph spaces indicated a similarity to the musk glands of crocodiles..... The glands

* *Fauna of British India including Ceylon and Burma.* (*Reptilia and Amphibia*). Vol. II. *Sauria*. By Malcolm A. Smith. (Taylor and Francis, London). 1935. Pp. xiii+440, 93 text-figures, 3 plates and 2 maps. Price 30*s*.

[1] Camp, C. L., "Classification of the Lizards," *Bull. Amer. Mus. Nat. Hist.*, 1923, **48**, 401-403.

[2] Wagler, J., "Natürliches System der Amphibien, mit vorangehender Classification der Säugehiere un Vögel," *Ein Beitrag zur vergleichenden Zoologie*, München, Stuttgart and Tübingen, 1830.

[3] Schæfer, F., "Ueber die Schenkeldrüsen der Eidechsen," *Archiv für Naturgeschichte*, 1902, **68**, Band I, 27-64.

[4] Cohn, L., "Die Schenkeldrüsen des *Cnemidophorus lemniscatus* Daud," *Zoo. Anz.*, 1904, **27**, 185-192.

[5] Tölg, F., "Beiträge zur Kentniss drüsenartiger Epidermoidalorgane der Eidechsen," *Arbeiten Zoolog. Inst. Wien*, 1905, **15**, 119-154.

[6] Félizet, J., "Recherches sur le Glandes Fémorales de *Lacerta muralis*," *Journ. d'Anat. Physiol.*, 1911, **47**, 333-370.

[7] Meissner, C. F., "Die Amphiborum quorandum Papillis Glandulisque Femoralibus," 1832, Basel.

are seemingly of functional significance and not vestigial or rudimentary structures."

As regards the evolution of the *external coverings of the eye* (p. 9), the author believes that "the simplest form of eye-covering is to be found in the Geckoes" and that this type has given rise to others by "the disappearance of the immovable transparent disc, its function as a covering for the eye being now undertaken by the eyelids. Whether it becomes thinned and so disappears, or whether it becomes united with the cornea," he is "unable to say". May we point out that some zoologists (*e.g.*, Johnson, 1927),[8] who have given thought to this problem, regard the gecko type of eye-covering as not simple, but specialised, due to an "excessive development and specialisation of the nictitans, which becomes quite transparent"?

Besides the Introduction, the volume on *Sauria* contains excellent systematic descriptions of the sub-order, families, genera and species of the region dealt with; complete synonymies of not only the generic and specific names, but also of those of the families and the sub-order; a glossary and general index; and a fairly complete bibliography. The author has examined the types of almost all the species mentioned and has taken great pains to make the work as authoritative and helpful as possible. He has followed the law of priority in nomenclature rather rigidly, and has carried it "into all groups, although the Rules of Zoological Nomenclature do not, at present, require it to be carried higher than genera". For our part, we doubt the utility of changing the nomenclature of zoological classification at the cost of common usage, especially in the case of groups higher than genera and species.

In going through the Bibliography, one observes the omission of several important papers, referred to in the text. One looks in vain, for example, for the papers of Weekes, 1929 and 1930 (referred to on p. 6 of the volume), Hingston, 1933 (the same page), Hewitt, 1929 (referred to on p. 3), etc. Much of the value of a work like the present one lies in directing our attention to the original contributions on the subject and we hope that Dr. Smith would give a more complete list of references in the coming volumes on Snakes and Amphibians.

Boulenger (1890) in his volume on "Reptilio and Banrachio" preferred to divide Lizards into two sub-orders: *Lacertilia* and *Rhiptoglossa*, the latter consisting of a single family, *Chamæleotidæ*. Dr. Smith, however, includes *Chamæleotidæ* along with the other Indian families of Lizards in the same synopsis (pp. 20–21) and places this family just after *Agamidæ*. This is in accordance with Cope's opinion that the Chamæleons are related to the Agamids, an opinion confirmed by Camp (1923).[9]

One might mention, perhaps, that in the case of one genus at least (*Hemidactylus*) no mention of the size and nature of eggs is made even though we have some records about them. Baini Parshad's article on *H. flaviviridis* (*Jour. Bom. Nat. Hist. Soc.*, 1916, **24**, pp. 834–838) has, apparently, not been available. It would probably be better also to have the glossary of each volume as complete as possible, irrespective of the fact that some terms have been explained in a previous volume. Such a procedure would make each volume of this series so independent of others as to make reference by a layman really easy and would facilitate his understanding of the common terms used in the text to a considerable extent.

Dr. Smith is a well-known herpetologist, and we are sure that his present work is really the best introduction so far published to the systematic study of Indian Lizards. He has produced a volume of decidedly high order, and Indian zoologists should be particularly grateful to him for it.

B. C. M.

[8] Johnson, G. L., "Contributions to the Comparative Anatomy of the Reptilian and the Amphibian Eye, chiefly based on Ophthalmological Examination," *Phil. Trans. Roy. Soc.*, 1927, **B 215**, 319-320.

[9] Camp, C. L., *op. cit.*, 333.

Research on Lac in Great Britain.

IT is two years since the Indian Lac Cess Committee deputed three research workers to England to carry out a scheme of research in the industrial uses of lac, in the fields of the paints and varnishes, the plastics and the electrical industries. In the preface to the first technical paper, Dr. Jordan refers to the several lines of investigation being pursued concurrently and the first bulletin deals with the isolation of the Pure Lac Resin, the economics of whose isolation and utilisation must, for the moment, remain an unsettled question. The paper by Dr. Bhattacharya and Dr. Verman on this subject of isolation of pure resin is a very valuable contribution which promises to find application in technological development of lac. Dr. Verman has discussed the industrial possibilities of pure lac resin, in a paper read at a joint meeting of the London section of the Plastics Group. The most hopeful application of the lac resin, which Dr. Verman has indicated, is in the manufacture of an insulating varnish for wire, which should be able to withstand elevated temperatures for long periods of time. The pure resin has a quicker rate of hardening than the original lac and this circumstance should extend the employment of the pure lac resin to regions where the "slow hardening" of untreated lac has been found defective. Another application of great promise is the manufacture of canning aluminium and tin foil lacquers. Experiments have shown that with pure lac resin, can be successfully made coloured lacquers, having good adhesion and non-sticky. Yet another possibility which Dr. Verman has indicated is the employment of the pure resin for electric insulating moulding. The chief difficulty in shellac moulding at the moment is the slow rate of heat-hardening and any process through which the time of hardening could be reduced, will be considered a useful technological development. Properties of the pure lac resin in this respect have not been investigated except to show that it possesses a quicker rate of hardening than shellac; with the addition of accelerators it may be possible to reduce further the time of hardening and in this direction we shall await with keen interest the results of Drs. Bhattacharya and Verman.

One pauses to reflect if all this work detailed above could not have been done in India at the Lac Research Institute at Ranchi or at the Indian Institute of Science, Bangalore. It is true both these Institutes have to a large extent pioneered researches on the various aspects of lac but what has been sadly lacking with respect to both of them is that close contact with the consuming industries, which have always been responsible for stimulating applied research. The Indian research workers who have now been stationed at the Paint Research Station at Teddington, have the enviable opportunity of facing the practical problems of the industry understanding their needs and meeting their exacting requirements through research. They have done well indeed but the Indian Lac Industry expects more work from them, if it should escape the crisis.

M. S.

Alchemy in China.

IN an interesting article appearing in *Nature* (1935, **136**, 287-88), Prof. J. R. Partington gives an account of an ancient Chinese Treatise on Alchemy, an obscure and mystic work of considerable historic importance. The treatise is *Ts'an T'ung Ch'i* of Wei Po Yang who flourished in the 2nd century A.D., and was called the 'father of Chinese alchemy'. This treatise has been recently translated by Dr. Lu Ch'iang Wu and annotated by Prof. Tenny L. Davies. The translation is a task of no small difficulty from which, the previous sinologists had turned away in despair. The treatise has been considered to be the earliest, in Chinese language. From the references to earlier Chinese alchemists it is reasonable to assume that for at least 2 or 3 centuries before Wei Po Yang, attempts to transmute base metals into gold and prepare elixirs of life were being made and alchemy in China and Greece was contemporary. "Dr. Wu and Prof. Davies are to publish later some alchemical chapters from Ko Hung, a celebrated Chinese Taoist Philosopher and Alchemist of the fourth century and the history of chemistry will be enriched by their work."

Research Notes.

Variation of the Mass of an Electron with its Velocity.

As is well known there are two theories of the electron leading to different expressions for the dependence of the mass on the velocity, namely the theories of Abraham and of Lorentz, the result of the latter agreeing with that of the Relativity Theory. Bucherer's experiments are taken to provide evidence for the correctness of the theory of Lorentz as against that of Abraham, but the accuracy of the experiments is not sufficient to accept them as conclusive. Sommerfeld's theory of the fine structure of hydrogen lines provides an indirect proof of the correctness of the Lorentz formula. However, a direct experimental proof was a desideratum and one is now provided by the experiments of M. Nacken described in *Annalen der Physik*, 1935, **23,** 313. Nacken has used cathode ray electrons accelerated through 200 kilovolts and 7 kilovolts respectively so that there was an advantage over using the β-rays from various sources in that the intensity of the beam could be increased and sharper lines could be obtained with shorter exposures. The cathode rays are deflected by electric and magnetic fields: there is however an improvement in that the electrons of 7 kv. and 200 kv. are made to trace the same path by adjusting the strengths of the electric and magnetic fields so that errors due to the geometry of the apparatus do not appear in the calculations. If J and J′ are the currents in the magnetic field-coils and V and V′ the potentials between the condenser plates required to produce the same deflection in the 200 kv. and 7 kv. electrons respectively and $\beta = 0{\cdot}164\ \frac{V/V'}{J/J'}$ then if μ and μ_0 are the masses of the two groups of electrons, $\frac{\mu}{\mu_0}\ \frac{\beta}{J/J'}$, =a constant = 0·166 according to Lorentz's theory but slightly variable and equal to 0·154, 0·153, 0·153, 0·152 and 0·150 under the experimental conditions used by Nacken. The actual values obtained for this quantity were 0·166, 0·165, 0·164, and 0·162 with a mean of 0·164 while the error in determining J/J′ might be 0·7% and that in V/V′ could be 0·6%. Since the results to be expected according to Abraham's theory differ from the experimental values by 6·1 %, 7% and 8·5% while the deviation of the mean result from Lorentz's theory is only 1·2%, Nacken concludes that his results decide definitely in favour of the theory of Lorentz.

T. S. S.

The Velocity of Light in a Partial Vacuum.

THE late A. A. Michelson had made arrangements to determine the velocity of light in vacuum but his death prevented his concluding the work. F. G. Pease and F. Pearson who were associated with him in this work have carried it on to a successful conclusion and an account of the results so far obtained is given in *Astrophysical Journal*, 1935, **82,** 26. The method used was that of the rotating mirror having 8 and 16 faces and the light travelled to and fro inside a steel pipe line, one mile long and evacuated to a pressure varying from 0·5 mm. to 5·5 mm. of mercury. The details of this stupendous undertaking are illustrated by beautiful photographs. The light-path used varied from 8 to 10 miles. The distance was accurately measured by comparison with a carefully measured base-line set up near the pipe line. The number of revolutions per second made by the mirror was correctly determined by strobscopic observation of a tuning fork synchronised with the rotating mirror, the tuning fork being compared with a freely swinging pendulum which was compared with a chronometer which in its turn was rated by means of time signals from Arlington. "2885·5" determinations of the velocity were made during a number of years and the mean value obtained for the velocity of light was 299774 km. per sec., the average deviation from the mean being 11 km./sec. As Birge has pointed out (*Nature*, 1934, **134,** 771), this result agrees with the values obtained by Mittelstædt (1928), Mercier (1923) and Rosa and Dorsey (1906) using other methods, and so the variation of the velocity of light postulated by Gheury de Bray and Edmondson may be only apparently confirmed by the measurements employing long base-lines.

T. S. S.

Photo-Oxidation in Near Infra-Red.

IN the photo-oxidation of organic substances in presence of chlorophyl, under favourable conditions one molecule of oxygen is absorbed per quantum of absorbed light, irrespective of the wavelength. If the

wavelength of the incident light is continuously increased, for any given substance, there will be a limit beyond which the absorbed quantum will be insufficient for the activation energy required for oxidation. This, in principle, simple method for determining the activation energy for autoxidation of organic substances, however, requires a dyestuff which absorbs in the red and infra-red, and also a filter that transmits in these regions. Chlorophyl is not suited for this purpose as it does not absorb even in the visible red region. H. Gaffron (*Berichte*, 1935, **68**, 1409) has discovered in Bakterio-chlorophyl (extracted from *thiocystis*) a suitable dyestuff for this purpose. A solution of this in acetone, containing thiosinamine as acceptor absorbs oxygen when irradiated with light even beyond 760 $\mu\mu$. This observation settles that it is not the oxygen that is activated by the sensitised dyestuff—as has been postulated by some, —since the energy required for the activation of oxygen to $^1\Sigma$ state is 37000 cal. corresponding to 762 $\mu\mu$, and thus light of longer wavelength would be ineffective.

M. A. G.

Inter-Molecular Forces in the Liquid State.

P. GIRARD AND P. ABADIE (*J. de Physique*, 1935, **7**, 295) have reported an interesting observation that the time of relaxation of a polar molecule in the liquid state, is extremely sensitive to the inter-molecular forces. Although Debye's theory of dispersion of dielectric constants is not strictly applicable to the pure liquid state, from the observed dispersion data, the characteristic period of relaxation τ can be evaluated by choosing a proper value for a in $\tau = \frac{4\pi \eta a^3}{T}$, where η is the viscosity of the liquid, T the absolute temperature and a is a constant having the dimension of molecular radius. This value of a gives a direct measure of τ after allowing for the influence of η and T. A comparison of the values of a shows, contrary to expectation, that the time of relaxation for different polar molecules in the liquid state varies *inversely* as the polarity of the molecule. By a process of elimination, it has been deduced that this remarkable relation must be attributed to the inter-dipolar forces prevailing in the liquid state. This is confirmed by the observation that when the polar liquids are diluted by non-polar solvents, the relaxation time increases to a maximum value of 3 to 7 times the original value, and then decreases. The nature of this curve would seem to indicate that the inter-molecular forces can have both effects, *viz.*, to increase or to decrease the time of relaxation according to conditions. It is briefly indicated that such effects can be attributed to the structure of the liquid state resembling more closely the crystalline state than the gaseous one.

M. A. G.

The Range of Action of Surface Forces.

BASTOW AND BOWDEN (*Proc. Roy. Soc.* (A), 1935, **151**, 220) have made viscosity measurements of thin liquid films, which throw light on the state of the liquid molecules in the neighbourhood of a solid surface. The results show that the solution of a liquid crystal has pronounced rigidity ; but no such effect is observed with normal liquids such as water, alcohol, acetic acid, etc., even in the neighbourhood of the freezing point. Furthermore, acetic acid shows a normal behaviour while it is in the supercooled state —a state in which there is comparatively high probability for the formation of the multimolecular layers. The results negate the conclusion of certain workers that there could be induced rigid structures of molecules extending from a surface to a distance of 1500 Å to 50000 Å. The length of such oriented structures, if they exist, is certainly less than 1000 Å and probably very much less.

K. S. G. D.

The Influence of the Electrode Surface on Anodic Reactions.

THE mechanism of the anodic oxidation of compounds at different electrode surfaces is of considerable practical and theoretical significance. Glasstone and Hickling (*J.C.S.*, 1934, 1878) have recently advanced the view that hydrogen peroxide is formed as a primary reaction product on the surface of the anode. This has been seriously questioned by Walker and Weiss in a recent paper (*Trans. Far. Soc.*, 1935, **31**, 1011). They have adduced definite evidence to the non-formation of hydrogen peroxide. The formation of oxide films which change the nature of the anode surface has however been detected. From the standpoint of quantum mechanics, there is a potential barrier between the electrode and the reacting

ions round it, which are in an adsorbed condition. It has been shown that for the discharge of an anion at the anode, the following relation should be satisfied.

$$\phi + V_a > E_{ion} + H_{ion} - \Delta A$$

where ϕ is the work function of the metal electrode, V_a the applied anode potential, E_{ion} the electron affinity of the adsorbed anion, H_{ion} the hydration energy of the anion and ΔA the adsorption energy of the process. In the above relation, both ϕ and ΔA depend upon the properties of the surface. Anodes with high Oxygen over-voltage (*e.g.*, Smooth platinum) favour the primary deposition of the anion, since the electron affinity of other anions is lower than OH^-. In the case of electrodes with low over-voltage (platinised platinum, metallic oxides), the primary discharge of the hydroxyl radicle may take part in the chemical oxidations on the anode.

M. P. V.

Study of Evaporation of Water from a Soil Surface.

THE dependence of fluctuations of water table on the surface evaporation and atmospheric pressure was investigated by Vaidhianathan and Luthra (*Research Publication*, November 1934, **5**, No. 3, Punjab Irrigation Res. Inst.) at Lahore during June, the hottest part of the year. Surface evaporation was studied for 11 days by exposing P_2O_5 in shallow bottles kept under a bell jar, while the fluctuation of water-table was studied by means of observation pipes fitted with strainers. It was found that while pressure has an effect on the fluctuation of the level of the water table, when the surface evaporation is high, however, the fluctuations of water table and pressure became out of phase and evaporation became the most predominating factor. The conclusions of the previous workers made in Australia and elsewhere that pressure is the main factor effecting the water table do not apply to the conditions existing in Lahore. It was found that there is continuity in the moisture content of the soil between the water table and the surface even though the water table is at a depth of 22 feet below the surface indicating that the water lost by evaporation is being continually replenished from the ground water level. This is in contradiction to Keen's observations made at Rothamsted that water which receded 6 ft. is not drawn up by surface evaporation. The amount of water evaporating from the surface was found to be $2 \cdot 7 \times 10^{-7}$grs. per sq. cm. per sec. on the average for June, when the maximum temperature was 66° C.

A Statistical Examination of the Uplift Pressure Data obtained from Model Experiments.

A NUMERICAL estimate has been made of the "Experimental Error" involved in the data obtained from model experiments to determine uplift pressures by Malhotra and Uppal (*Research Publication*, Jan. 1935, **1**, No. 5, Punjab Irrigation Res. Inst.). Attention was confined to the variations of "percentage drop of pressure" at individual pipes, the observations being taken from the same model though the head was varied. 97 individual pipes were used for each set of observations and they have been classified into 6 groups depending upon the experimental conditions. Eliminations due to choking and other causes have been made of some individual pipes. The analysis of variance due to Fisher was applied to the figures for "percentage drop of pressure". It was found (i) "that the upper limit of the 'Experimental Error' for any group of observations is less than 0·50" and (ii) that "all but about 1 per cent. of the observations would fit into a range of 3E on either side of the mean value for the pipe"; (iii) "In only one case 3E was as high as 1·5 and in all other cases it is less than 1·0"; and (iv) "An increase in the dimensions of the model did not affect the magnitude of the error."

Oil Formation in the Groundnut.

THE preference accorded to Indian groundnuts in the British market under the Ottawa Agreement is considerably neutralised by the poor quality of the Indian nuts as evidenced by the high free fatty acid content of the consignments from this country, the nuts from the Coromandel Coast ports being particularly bad in contrast with those from the West Coast ports, Mormugao and Bombay. An investigation into the causes affecting the quality of the groundnut has been undertaken by J. J. Patel and C. R. Sheshadri and the results of a study of the rate of oil formation and the effect of early harvest on the oil content are published (*Indian J. of Agr. Sci.*, 1935, **5**, Part II). There is, throughout the period of development of the seed, a gradual and uniform

gain in the oil content and reduction in the free fatty acid content. The harvest of groundnut even one week before the kernels are fully ripe increases the free fatty acid content and reduces the oil content by about five per cent. Premature harvest is thus suggested as one of the causes of low quality. The other effects of such early harvesting such as the high moisture content and the need for prolonged drying and deterioration by fermentation are being studied.

A. K. Y.

Factors affecting the Absorption of Selenium from Soils by Plants.

ANNIE M. HURD-KARRER records the results of further studies on the toxicity of selenium to plants, now that the subject of this toxicity has assumed importance, owing to the fact recently established that this toxicity is communicated to animals growing on such vegetation (*J. Agri. Res.*, 1930, **50,** No. 5). The work relates to pot culture studies conducted with two different kinds of soils "the Keyport clay loam" and "Pierre clay". Of the 17 different kinds of plants grown, the cruciferæ mustard and Broccoli absorbed the largest quantities, 1240 and 1180 parts per million respectively, while at the other extreme come the grain crops, and about midway the other crops, *viz.*, sunflower, flax, sweet-clover, alfalfa pea and spinach. The cruciferæ showed no outward signs of suffering or abnormality though they absorbed the largest quantities, while the gramineæ generally suffered most, the intermediate class remaining normal with the exception of the sunflower. The factors affecting the absorption by wheat of selenium added as sodium selenate to the soil and the resulting toxicity to this crop are summarised as available sulphur, soil type, percentage of sand, method of adding selenium, the form of selenium added and the growth of previous crops. It is suggested that the tendency of a crop to absorb selenium depends on its tendency to absorb sulphur, as in the case of the cruciferæ. Sodium selenate is absorbed by wheat more in the Pierre clay than in the Keyport clay loam. Applications of free sulphur reduce the absorption by wheat of the naturally occurring selenium in soils as well as that added as sodium selenate. Gypsum is similarly effective. The addition of quartz sand to Keyport clay loam increases the toxicity of the selenate in proportion to the percentage of sand. Sodium selenate is not easily leached and is partially retained in the upper layers. Elemental selenium is apparently unavailable and non-toxic to wheat at least in quantities up to 200 parts per million in Keyport clay loams. The selenium was more toxic in the form of sodium selenate than in the form of selenite. Sodium selenate was either changed to a less toxic form or reduced to a sub-toxic concentration by the growth of successive crops of wheat.

A. K. Y.

The Duration of Life in an Albino Rat Population.

B. P. WILSON AND N. M. SHEARD (*Proc. Roy. Soc. Edin.*, **55,** Pt. 1) have, for the purpose of presenting the data on the life span of the albino rat, divided its life into two phases. The first phase comprises the span of life spent by the rat in greater or less dependence on its mother; this phase ends during the fourth week post partum. The second phase comprises life after weaning. During the period following weaning very few animals died under the conditions in which they were maintained.

Data relating to 250 litters chosen at random are presented where the total number of young in these litters was 1,607. Of these a total of 492 animals died, or were killed by their mothers before the age of 30 days; while 1,115 survived upto or beyond this age. This would correspond to a death rate during this first phase of about 30 per cent. It was found difficult to establish in any given case whether death of either a litter or a single young was due to low vitality or to accidents such as cannibalism or squashing of young by the mother because the latter fails to assume the appropriate "nursing posture". These factors were eliminated when once the young was separated from their parents. It has been shown that not only is the mean duration of life shorter in males but the terminal age reached by females exceeds the terminal age of males. The force of mortality rises after the ninth month of life in geometrical progression.

Fœtal Respiration.

J. BARCROFT'S Croonian Address on Fœtal Respiration (*Proc. Roy. Soc. Lond.*, 1935, **118** (B), No. 808), attempts to state the principal facts known about the subject in the Mammalia. Needless to say that the

respiratory system goes hand in hand with that of the circulatory system. The umbilical arteries convey blood deficient in oxygen to the placenta, while the richer blood returns to the inferior vena cava by means of the umbilical veins. It is pointed out that the volume of blood passing through the fœtal heart and the oxygen consumption of the fœtus bear a relation to the weight of the fœtus itself, though in the case of the rabbit, the placenta reaches its maximum size before the culmination of the progressive growth of the fœtus. And on account of the rise in arterial pressure, more blood passes through the fully grown vascular bed in the placenta. Moreover the oxygen utilised by the fœtus bears a constant relation to the weight of the fœtus over last half of fœtal life. Towards the end of pregnancy the relationship stands thus: On the fœtal side a rapidly growing fœtus with a fœtal irrigation of the placenta and the consumption of oxygen with reference to the weight of the fœtus is present while on the maternal side neither the blood flow nor the size of the placenta increases. Therefore the "Oxygen difference" between the blood in the umbilical artery and vein should be the same whilst the maternal blood leaves the uterus increasingly reduced as pregnancy advances. That this is so is clearly shown by the dark blood emerging from the pregnant side of the uterus of the rabbit, and as regards the oxygen difference, the factors involved in this are that "the oxygen breaks away from the hæmoglobin of the mother, becomes dissolved in the plasma of the maternal blood and attains a certain partial pressure in that plasma. It then diffuses to the plasma of the fœtal blood in which it necessarily exists at a lower pressure than that which it set up in the plasma of the mother. The oxygen then passes to the hæmoglobin which it saturates up to whatever point may be possible at the partial pressure in question." Further it has also been noted that "the placental membrane is incapable of maintaining any considerable difference of pH between the maternal and fœtal plasma and that the hæmoglobin of the fœtus is different from that of the mother. Regarding the passage of blood in fœtus it has been long known that most of the arterial blood arriving by the inferior vena cava enters the left ventricle after passing through the foramen ovule into the left auricle ; from the ventricle a large part enters the carotids and proceeds to the head region. The blood from superior vena cava enters the right ventricle through the right auricle; from the ventricle the blood is projected through the ductus arteriosus into the aorta and the mixed blood passes to the body. Of the 300 c.c. of blood which traverses the fœtal heart, about 150 c.c. goes to the head and other 150 c.c. to the abdominal aorta ; of the latter 150 c.c. perhaps 100 c.c. goes to the placenta for aeration and 50 c.c. to the body of the fœtus for the nourishment of the same." Thus a great volume of blood finds its way through the ductus arteriosus but how this flow is stopped at the time of birth is left unanswered since it is purely a post-natal problem.

The Charnockite Series of Uganda, British East Africa.

EVER since Sir Thomas Holland recognised the Charnockite series in India as intrusive plutonic rocks, similar members have been studied in other areas, but still the origin of such rocks has not been finally determined. Some petrologists believe that charnockites are the result of assimilation of argillaceous sediments, while others like Vredengurg hold that metamorphism alone is responsible for the formation of such a group of rocks ranging from acid to ultra-basic with a uniformity of character. Adams who studied the charnockite rocks of Ceylon could not come to any definite conclusions. A comprehensive study of the charnockites from Uganda, British East Africa, has been made recently by A. W. Groves (*Q.J.G.S.*, **91**, No. 362). His study includes many chemical analyses, comparison with similar rocks in other areas, especially in India, and a detailed study of the development of Hypersthene. At the end of his paper he has tabulated a series of arguments to show that the charnockites do not result from the assimilation of sediments by magmas. The marked presence of "dry minerals," universality of secondary characters, linear arrangement of minerals and "the appearance of successive ferromagnesian minerals in the reverse of the accepted order for plutonic rocks of the calc-alkali series" have led him to conclude that the charnockites of the Uganda series of rocks are the result of plutonic metamorphism of normal igneous rocks. In view of such a conclusion by Groves, it is desirable to review the study of Indian charnockites to aid their correlation with similar rocks occurring in distant parts of the globe.

The Correlation of the Pre-Cambrian Granites by means of Heavy Mineral Analyses.

In many localities correlation of isolated outcrops of igneous rocks by thin sections and field studies are beset with numerous difficulties. In recent times such obstacles have been overcome to a certain extent by the study of the heavy mineral analyses, and in most cases successful correlations have been established. J. T. Stark and F. F. Barnes (*Geological Mag.*, 1935, No. 854) during the course of their study of the closely related Pikes Peak and Silver Plume Granites of the Pre-Cambrian Age in the Sawatch Range of Central Colorado have shown by means of the heavy mineral analyses that outcrops belonging to the two series of granites differ fundamentally, in their heavy mineral constituents. In the Silver Plume granite there is a large percentage of Zircon, while the Pikes Peak granite is characterised by a large percentage of Titanite. By a series of curves they have shown that though there are a large number of minerals common to both the series of granites yet the relative proportions of certain of the important minerals like Zircon and Titanite are sufficiently marked for being made use of in correlation.

Sugar Industry of India, 1933—34.*

The year 1933–34 was one of general depression in the sugar industry of the world. The total production of sugar during that year exceeded the consumption by about 740,000 tons. But mainly as a result of protective tariffs, the Indian sugar market did not suffer any dislocation and on the other hand accommodated the produce of 112 factories which operated during that year. There was a marked decline in the total sugar imports into India. On the cultivation side, though the acreage under cane was less than in 1932, the cane grown exceeded the figure for that year in consequence of the increasing adoption of improved varieties of cane. The severe earthquake in Bihar on 15th January 1934 was responsible for a large damage to the cane crop. The factories designed to work were 123 during 1933–34 but only 112 were in operation. The total produce was 453,965 tons which was 163,788 tons more than the produce of 1932–33. In spite of a large number of new factories working and the loss in Bihar due to earthquake, the average recovery for the whole of India showed a slight increase over the previous year's figure.

Advancement in technical and scientific work was not lacking. The research stations in Coimbatore and Pusa and those in other provinces demonstrated the increasing usefulness of many Coimbatore varieties of cane which are rapidly ousting the local varieties out of cultivation. Financed by the Imperial Council of Agricultural Research the work on the design of a small power-driven mill started in 1931 resulted in success and the mill was standardised for cane conditions in Bihar and Orissa.

Of great importance to Indian Sugar Industry are the Government of India Acts Nos. XIV and XV of 1934 which provide for the levy of an excise duty of factory sugar and empower local governments to restrict sugarcane dealings and fix cane prices in such a manner as to secure to the growers a fair price for their produce.

The total value of sugar machinery imported into India during 1933–34 was Rs. 3.36 crores of which nearly Rs. 2 crores were spent on British machinery alone. The import of machinery in 1932 was only half of this value.

Besides the 453,965 tons of sugar made in factories direct from cane, 225,000 tons were produced by indigenous process and 60,000 tons by refineries making a total production of 738,965 tons. Consequent to this large production there was also a sharp fall in the quantity of imported sugar. Gur production in 1933–34 was 10.8 per cent. higher than in the previous year with a corresponding fall in molasses imports.

The position of sugar trade of Java and Cuba is of interest. Java suffered enormous fall in her sugar exports owing to severe competition from other countries and the large increase in the production of British India. Under the management of sales by the 'NIVAS', quantities of sugar in excess of the production of 1933–34 were disposed of. During the year under review only 99 factories operated in Java as against 166 in the preceding year. The acreage under cane was only 208,947 in 1933–34 as against 423,924 in 1932. The Cuban sugar trade of 1933 was influenced considerably by the inflationary policy of the U.S. Government, the attempt at the formation of a sugar crop restriction and marketing agreement, the possibility of reduction in Cuban duty and finally the overthrow of Mochado Government in Cuba.

Though the world sugar industry of 1933-34 shows a large excess of production over consumption figures in contrast to the previous year, the outlook of Indian sugar industry is definitely better to-day, inasmuch as fear of over-production is lessening. The excise duty has put a wholesome check on excessive expansion of factories and, at the same time, the country has shown signs of increasing sugar consumption.

G. Gundu Rao.

* Review by R. C. Srivastava, Supplement to the *Indian Trade Journal*, Aug. 15, 1935.

Science Notes.

Improvising a Paraffin Bath.—Mr. Beni Charan Mahendra, St. John's College, Agra, writes under date 24th August, 1935:—"Last year, as I did not have sufficient money to buy a paraffin bath for my room, I made one for myself according to a suggestion of McClung.[1] The apparatus did not cost me more than five rupees, and besides being simple, it works as efficiently as an elaborate water-bath with a thermo-regulator can. I pass on the suggestion in the hope that somebody in a situation similar to mine may find it useful.

All that is required is a 100–150 watt gas-filled, electric bulb, a small glass beaker and a clamp-stand. The apparatus is set up as shown in the figure, the beaker is filled up with the paraffin

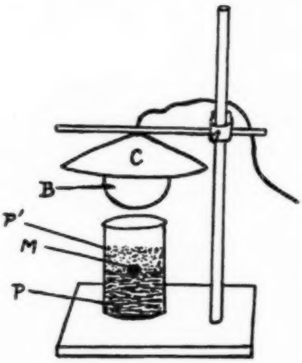


Fig. 1.

The Improvised Bath.

B, electric bulb; C, Shade for the bulb; P, Solid paraffin; P′, Molten paraffin; M, Object to be infiltrated.

of desired melting-point, and the bulb is lighted. The heat given out by the bulb melts the upper layers of paraffin, while the lower layers remain solid. According to the principle of latent heat, the temperature of the paraffin cannot rise above its melting-point as long as there is some solid paraffin left over. The height of the bulb can be adjusted with this end in view, and there is absolutely no necessity of any thermo-regulating device. The object to be imbedded can be transferred to this bath as soon as the upper paraffin has melted. To keep off dust from getting into the paraffin, a sufficiently large wooden-case can be modified to accommodate the whole apparatus inside.

Another cheap method of building a paraffin bath for oneself, which I have not tried, is given by Ballantyne.[2]

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[1] McClung, C. E., *Handbook of Microscopical Technique.* (Paul B. Hœber, Inc., 1929, 13.)

[2] Ballantyne, F. M., *An Introduction to the Technique of Section-Cutting* (E. & S. Livingstone, Edinburgh, 1928, pp. 23—25.)

* * *

Recent Archæological Discoveries in S. India.—The discovery of (1) *an inscribed pot from Guntur District*, by Prof. K. A. Nilakanta Sastri, (2) *a Chola Image of Manikkavachaka and some other Images found associated with it*, by Mr. T. N. Ramachandran, and (3) *Prehistoric pottery from the Cuddapah District, including a sarcophagus in the form of a ram*, by Mr. M. D. Raghavan, are among the important announcements made at a recent meeting of the Archæological Society of South India. The pot described by Prof. Nilakanta Sastri bore an inscription in Brahmi characters of the end of the second or the beginning of the third century A.D. and probably recorded that the contained ashes were those of Aryadeva, a man known to have been a pupil of Nagarjuna. The image of *Manikkavachaka*, discovered by Mr. T. N. Ramachandran, was found buried near Madukkur in the Pattukottai Taluk of Tanjore, and bore an inscription in the hand in characters of the period of later Cholas. Mr. M. D. Raghavan's discovery refers to pottery found at Markapuram in the Badval Taluk of Cuddapah District, at a depth of six feet with a unique *sarcophagus*. The sarcophagus possessed a clearly modelled head of a ram the curved horns being emphasised but the ears and tail omitted. It contained a fractional human interment, evidently a secondary burial. The bones were much decayed. The worn state of the molars and the condition of the skull sutures show them to have come from an adult person. It is hoped that this find is only the beginning of a series of similar ones, ultimately leading to the establishment of a much-needed pottery time-scale for South India.

* * *

Some Chemists of Yesterday—formed the subject of the inaugural address to the Chemical Society, University of Mysore, delivered by Dr. Gilbert J. Fowler, D.Sc., F.I.C., on Saturday, the 31st August at Central College, Bangalore. The address was largely autobiographical and contained glimpses of the inspiring work and character of the giants of chemistry, Professors Roscoe, Schorlemmer, Victor Meyer, Gatterman, Dixon, Perkin and others. "The chemist who had learnt his science during the last decade or so, would seem to belong to quite a different school from that of the preceding fifty years." "Modern Chemistry is concerned with the intimate nature of atoms and molecules and their individual reactions, while in the days before isotopes we dealt with mass reactions and were concerned mainly with mass phenomena."

Referring to the teaching of chemistry in India, the lecturer often felt that Indian students suffer under a disability in that much of their training is of necessity at second hand. "Nothing at second hand, *e.g.*, could equal the impressiveness of a lecture by Roscoe on Vanadium, when he described the researches which had enabled him to place this element in its proper place in the periodic table and showed samples of the numerous compounds isolated in the course of the research. In this way it was learnt how new knowledge was actually made and the whole subject was removed from the text-book atmosphere." The number of those who have made real "Path-breaking" research is

increasing in India so that the Indian student has not necessarily to go to Europe for Education. Dr. Fowler concluded the address with a quotation from a recent discourse of Professor Bone, himself a student and colleague of Dixon, as embodying an ideal which may be kept in mind by the students of present day.

"It was a rigorous school of research to which we were admitted, and its discipline was such as only strong minds could stand. As I have already said elsewhere, Dixon's singularly clear and penetrative mind referred everything to the final test of a well-ordered experiment critically carried out without hurry or bias and with the results checked at every point. He impressed upon all the paramount importance of accuracy and truth, together with the highest standard of experimental proof step by step, by a process of exclusion, until it had been narrowed down to a single issue, which finally had to be tested in every possible way. We were taught also to criticise our results, to eschew all rash speculation, and to limit ourselves to such explanations as were proven or provable. Our theories were to be regarded merely as working hypotheses, no more than serviceable tools for accomplishing, further advances, and as such always to be subordinated to facts and discarded when outworn."

* * *

Travancore Rubber Factory.—With a view to utilising the raw materials produced in the State, a rubber factory, equipped with modern tubing machines, hydraulic presses, braiding and hose making machines, vulcanisers, spreading machines, etc., has been started at Trivandrum. Messrs. Hermann Berstorff supplied the major portion of the plant and the detailed plan and estimate were prepared by Mr. John Helen, the State Rubber Expert and Engineer, who was formerly Rubber Expert to the Lakshmi Rubber Works, Karachi. The Rubber Factory is the first of its kind in India and is a pioneer enterprise started by the State. Travancore is the largest rubber producing tract in India including the Native States, with an area of 95,800 acres, under rubber, and accounts for more than 75 per cent. of the rubber of very good quality in South India. It has large deposits of very fine China clay, an essential ingredient for the manufacture of rubber goods and plenty of educated and skilled labour is also available.

* * *

The 31st Half-Yearly Meeting of the Indian Central Cotton Committee.—The 31st Meeting of the Indian Central Cotton Committee commenced its session on the 19th of August in Bombay under the Presidentship of Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-Chairman of the Imperial Council of Agricultural Research. In response to an invitation, His Excellency the Governor of Bombay was present. Among others present were the Hon'ble Khan Bahadur D. B. Cooper and the Hon'ble Diwan Bahadur S. T. Kambli.

In pursuance of the policy of encouraging long staple cotton in all tracts in India, suitable for it, the proposals of the Chief Agricultural Officer in Sind for the establishment of a compact block of long staple cotton of 300,000 acres in the Barrage areas of Sind by licensing of gins and presses, use of special marks in the licensed factories, seed supply organisation and organised marketing, had received the approval of the Committee at its August 1934 meeting. The Committee after a long discussion adopted a resolution urging the Local Government to translate their recommendations into action without delay and suggesting that the compact area be reserved for the growth (from specially selected government seed) of long staple cotton only, such as 289-F and N.T. and also that the Cotton Transport Act be introduced to prevent the importation of *kapas* from outside areas.

The first annual report of the Lancashire Indian Cotton Committee was considered by this Committee and it expressed its high appreciation of the efforts made by the Lancashire Committee to extend the use of cotton of Indian growth in Lancashire as described therein. The Indian Central Cotton Committee assures the Lancashire Committee of its desire to co-operate to the fullest extent possible in all matters affecting the interests of both bodies.

The Committee noted with satisfaction the Bombay Government's response to its representations for the elimination, by legislative action, of Goghari cotton in the Surat area, the spread of which in recent years has been a serious danger to 1027 A.L.F. The Local Government propose to introduce at an early session of the Council, a Cotton Control Bill on the lines of Madras Cotton Control Act, to prohibit the cultivation of Goghari cotton, its mixture with any other kind, its possession or its use for trading purposes.

The report of the Technological Research Sub-Committee was approved. It showed that a total number of 434 samples were received for tests during the period under review as against 311 during the corresponding period last year. The Committee recorded its appreciation of the valuable work of the Director of the Technological Laboratory, Matunga, whose informative brochure dealing with the work of the Laboratory for the last 11 years was considered and approved. This brochure will shortly be available to the general public.

The progress reports of 30 agricultural research schemes and 15 seed distribution schemes, all of them financed by the Indian Central Cotton Committee, were considered by the Committee and approved. The Jayawant and Gadag No. 1 Distribution and Extension Scheme was sanctioned for 5 years at an estimated expenditure of Rs. 2,66,772. A scheme for the introduction and extension of B.D. 8 cotton which is wilt resistant, in Broach District, was sanctioned for a period of 3 years at a total cost of Rs. 10,460. The Committee approved of the idea of calling a conference of scientific workers on cotton to be held in Bombay soon after the 1936 monsoon meeting of the Committee.

The Central Provinces Government doubted advisability of prohibiting the cultivation of Garrow Hill cotton which had detrimentally affected better types in the Central Provinces and Berar. They thought that the spread of such inferior cotton could be discouraged by penalising its mixing with cotton of superior varieties and decided to undertake legislative measures to penalise the sale of mixed cotton as pure. The Committee decided to request the Central Provinces Government to reconsider the question of prohibiting the growing of Garrow Hill cotton,

as in its opinion the action which the Local Government proposes to take will not prevent the spread of this inferior cotton. The known presence of even small areas of an inferior cotton tends to lower prices in the markets where this cotton is sold and the growers of better quality cotton also suffer.

* * *

The Association of Economic Biologists, Coimbatore.—The Association of Economic Biologists which was founded five years ago, fulfils the supremely important function of bringing together the various specialists of the Coimbatore Agricultural Research Station for (1) taking stock of progress achieved in the different branches of Agricultural Science, and (2) discussions of research problems engaging the attention of the scientific officers of the station. Short notices of the activities of the Association have appeared in the columns of *Current Science* from time to time. The Proceedings of the Association issued annually reflects the activities of the Association. A brochure has recently been issued by the Association covering the period 1934–35. It comprises of six original papers and a number of highly informative lectures constituting an impressive record of the work of the Association.

H. B. S.

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Correlation between Laboratory Tests and Observed Temperatures in Large Dams.—His Majesty's Stationery Office (*Building Research Technical Paper No.* 18. Price 9*d*. net. Post Free 10*d*.)—A knowledge of the temperatures likely to be attained in large masses of concrete is of the greatest importance. The present paper shows, by comparing records made in three large dams now under construction with time-temperature curves obtained in the laboratory, that these temperatures may be predicted from data given by the adiabatic method of curing concrete. The method was described in Technical Paper No. 15. (Price 1*s*. 3*d*. Post Free 1*s*. 5*d*.)

* * *

The Effect of Lighting on Efficiency Rough Work (Tile-Pressing).—His Majesty's Stationery Office (Price 4*d*. Post Free 5*d*).—The report describes experiments undertaken to find out the effect of increasing the illumination in the case of a perfectly simple operation (tile-pressing) for which good lighting was not previously considered necessary. The results show clearly the advantage to be gained by maintaining a reasonably good level of illumination.

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Van Nostrand's Chemical Annual.—Our attention has been drawn to the omission of the name of the Publishers in the bibliographical details relevant to the review of this highly useful handbook, containing useful data for analytical manufacturing and investigating chemists, chemical engineers and students, published in the July number of *Current Science* (Vol. IV, No. 1, p. 68). Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, London, W.C. 2, are the publishers of this important publication and they also act as agents for the book in the British Empire. The omission is regretted.

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We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 50, Nos. 8–12, and Index to Vol. 49.

"Journal of Agriculture and Live-Stock in India," Index to Vol. III.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4314–4317.

"Indian Journal of Agricultural Science," Vol. 5, Pts. II and III.

"Contributions from Boyce Thomson Institute," Vol. 7, No. 2, April—June 1935.

"Biochemical Journal," Vol. 29, No. 7, July 1935.

"The Journal of the Indian Botanical Society," Vol. 14, No. 2, June 1935.

"The Journal of the Institute of Brewing," Vol. XLI (Vol. XXXII, New Series), No. 8, August 1935.

"Canadian Journal of Research," Vol. 13, No. 1, July 1935, Sections A, B and C, and Index to Vol. XII, Jan.—June 1935.

"Chemical Age," Vol. 33, Nos. 839–842.

"Ceylon Journal of Science," Section B, Zoology and Geology, *Spolia Zeylanica*, Vol. 19, Part 2.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 8.

"Indian Forester," Vol. LXI, No. 9, September 1935.

"Forschungen und Fortschritte," Vol. 11, Nos. 22 and 23/24.

"Marriage Hygiene," Vol. II, No. 1, August 1935.

Punjab Irrigation Research Institute, Research Publication No. 8, Vol. II, Nov. 1934: "Protection below Khanki Weir," by J. P. Gunn.

Punjab Irrigation Research Institute, Research Publication No. 9, Vol. II, January 1935: "Influence of an Upstream sheet pile on the Uplift Pressure on a Floor," by N. K. Bose.

University of California Publications in Agricultural Science, Vol. 6, No. 10: "The Chromosomes and Relationship of *Crepis Syriaca* (Borum)," by Donald Ross Cameron.

University of California Publications in Agricultural Science, Vol. 6, No. 11: "Chromosomes and Phylogeny in Crepis," by Ernest B. Babcock and Donald R. Cameron.

Government of India Publication, March 1935: "Monthly Statistics of the Production of Certain Selected Industries of India."

"Rothamsted Experimental Station, Report for 1934."

"The Geological, Mining and Metallurgical Society of India, 11th Annual Report for the Session 1934–1935."

Imperial Council of Agricultural Research, Scientific Monograph No. 5, "The Bombay Grasses," by E. Blatter and C. McCann: Illustrated by R. K. Bhide.

Imperial Council of Agricultural Research, Scientific Monograph No. 6, "Helminth Parasites of the Domesticated Animals in India," by G. D. Bhalerao.

"Report of the Zoological Survey of India for the years 1932 to 1935."

"Annual Report of the Imperial Council of Agricultural Research for the year 1933–34."

"Nature," Vol. 136, Nos. 3430–3433.

"The Journal of the Bombay Natural History," Vol. 38, No. 1.

"The Journal of Chemical Physics," Vol. 3, No. 8, August 1935.

Academies and Societies.

National Institute of Sciences of India:

August 23rd, 1935.—SYMPOSIUM: *Discussion on Problems of the Ionosphere.* S. K. MITRA: The Ionosphere constitutes the vast stretches of ionised regions in the upper atmosphere, the lower boundary being at a height of about 90 kms. The upper boundary extends beyond 400-500 kms. It is explored experimentally by the study of the reflection of wireless waves. Such studies have given information about the height, ionisation density, density gradient, structure, intensity of the magnetic field, collisional frequency between electrons and neutral atoms or molecules at ionospheric height, polarisation of the down-coming waves and temperature of the ionosphere. The main ionising agency is the ultra-violet rays of the sun. S. K. BANERJI: *Thunderstorms and Magnetic Storms in Relation to Ionosphere.*—The influence of the earth's magnetic field is such as to make the ionosphere an æolotropic medium and owing to the difference in the group velocities of the two components, a single wireless pulse may be split into a doublet. Magnetic storms are connected with abnormal ionisation and this is probably associated with high speed charged particles from the sun. There appears to be extraordinary variability in ionospheric weather and it would be interesting to correlate them with magnetic variability. The sudden appearance of bursts of abnormal ionisation is associated with thunderstorms. There is a close relationship between thunderstorm activity and sun spots. G. R. TOSHNIWAL: *Ionosphere at Allahabad.*—By the method of Breit and Tuve, it has been found that normally a 4-kilocycle wave is reflected from the F-layer at a height of about 250 km. The ionisation decreases gradually after sunset and the equivalent height from which the reflected wave emanates gradually increases and about 2 hours after sunset the 4-kilocycle wave is not reflected from the ionosphere. At the time of the lunar eclipse on January 19th, 1935, using a 75-metre wavelength it was found that the equivalent height of the F-layer was almost constant up to 18 hours 20 minutes, after which it rapidly rose to 400 km. and then began to fall and was minimum when about three-quarters of the moon was dark. After totality the equivalent height again began to increase and within 20 minutes no echo could be seen due to electron limitation. P. SYAM: *The D-Layer.*—The detection of echoes from a virtual height of about 55 km. gives direct proof to the existence of a low layer at this height during the day time. The echoes are of infrequent occurrence. Other evidences also exist in support of the presence of the D-layer. It has been found that during the day time there is a frequency band which is reflected from the E-region. The upper limit of the band is due to the penetration of the E-layer, and may be termed the "penetration limit". The lower limit which may be termed the "Absolute limit" is due to the absorption by the D-layer on account of large collisional frequency present therein.

Indian Academy of Sciences:

August 1935. SECTION A.—P. S. SREENIVASAN: *Raman Spectra of Isoprene, Dipentene, and Ocimene.*—Specially chemically pure substances have been prepared and studied. T. S. SUBBARAYA: *Analysis of the Spectrum of Trebly Ionised Zinc: Zn IV.* C. S. VENKATESWARAN: *The Raman Spectra of Iodic Acid and the Alkaline Iodates as Solids and Solutions.*—The dissociation of iodic acid is incomplete even at concentrations of 0·5 N. It is suggested that the acid is polymerised in the solutions to an appreciable extent, the polymerisation decreasing with dilution. The IO_3 ion exhibits all the four vibration frequencies and two parallel vibrations exhibit splitting, indicating that the IO_3 radical is pyramidal in structure with the I atom close to the plane of the O atoms. A number of low frequency oscillations have been observed and an explanation suggested. R. ANANTHAKRISHNAN: *On the Convergence Error in Depolarisation Measurements.*—It is shown that the observed values of the depolarisation would be higher than the genuine values by a correction factor which involves the square of the angle of convergence. The necessity for the perfection of the optical parts used in depolarisation work is emphasised. N. S. NAGENDRA NATH: *The Dynamical Theory of the Diamond Lattice.—Part III. The Diamond-Graphite Transformation.* The temperature at which diamond becomes unstable and transforms to graphite is calculated and is shown to be in good agreement with the experimental determinations. R. ANANTHAKRISHNAN: *Redetermination of the Depolarisation of Light Scattering in Gases and Vapours.*—The corrected results with improved technique yield in general much smaller values than hitherto reported: the results are in greater agreement with theory. P. S. VARADACHARI: *Influence of the Formation of Hydrates on the Diamagnetism of Chemical Compounds.*—Results are reported on the aqueous solutions of sulphuric acid, acetic acid and sodium sulphate, over the complete range of concentrations. S. CHOWLA: *Irrational Indefinite Quadratic Forms.* M. SURYANARAYANA: *Positive Determinants of Binary Quadratic Forms whose Class-number is 2.* I. CHOWLA: *On Sums of Powers.* G. S. DIWAN AND V. V. NARLIKAR: *A Practical Financial Transaction.*—It is proved straight from the definition that a *practical* transaction admits of only one rate of interest. The multiplicity of the rate of interest for a transaction shown by Misra is only mathematically possible. G. R. GOGTE: *Chemistry of β-Aryl Glutaconic Acids. Part II. Condensations with Phenolic Ethers.* H. GUPTA: *On the P-Potency of G* (p^μ-1, *r*). B. VENKATESACHAR AND L. SIBAIYA: *Iridium Isotopes and their Nuclear Spins.*—The hyperfine structure patterns of some of the significant arc lines of iridium have been studied. Two isotopes of mass 191 and 193, abundance ratio 1 : 2, and nuclear spins $\frac{1}{2}\frac{h}{2\pi}$ and $^3/_2\frac{h}{2\pi}$ have been distinguished. The estimated atomic weight 192·4 shows that the accepted chemical atomic weight 193·1 is too high.

SECTION B.—H. CHAUDHURI AND P. L. KOCHHAR: *Indian Water-Moulds—I.*—The cultural characteristics of 20 species of water-moulds, some of which have not been noted before in India, have been described and fully illustrated. S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric Mill in Decapoda VI.*

The Structure of the Gastric Mill in Natantous Macrura—Penœidea *and* Stenopidea : Conclusion. —The various types of gastric mills found in the Decapoda can be arranged in a series ranging from simple to complex. Reptantous habit is associated with the possession of a complex gastric mill and simple mandibles and the Natantous habit with the possession of a reduced gastric mill and complex mandibles. H. S. RAO : *The Structure and Life-History of* Azolla pinnata *R. Brown with Remarks on the Fossil History of the Hydropterideæ.*—Fertilisation takes place in September or October. The resulting fresh plants mature in spring. By about April the sporocarps ripen and are shed. The spores rest during summer. The megasporocarp with the attached massulæ floats up before fertilisation. A. SREENIVASAN : *Investigations on the Rôle of Silicon in Plant Nutrition. Part II. Adsorption of Silica in Soluble Forms by Colloidal Oxides of Iron and Aluminium.* The possible significance of silicate adsorption in relation to phosphorus resorption in soils is indicated. Y. V. NARAYANAYYA AND V. SUBRAHMANYAN : *Estimation of Nitrogen by Fumeless Digestion. Part I.*—The material is first boiled with manganous sulphate and sulphuric acid (2 : 1) for 30 minutes. Potassium dichromate is next added and the boiling continued for a further period of 30 minutes after which the digest is reduced with zinc and distilled with excess of alkali, as in the Kjeldahl procedure.

The Academy of Sciences, U.P. :

An ordinary monthly meeting of the Academy was held at Allahabad on the 27th July, with Prof. N. R. Dhar, President of the Academy, in the Chair. The following papers were read and discussed:—

(1) "The Chemical Examination of the Fruits of *Lagenaria vulgaris* Seringe (bitter variety)". Part I. The Constituents of the Oil from the Seeds," by Radha Raman Agarwal and Shikhibhushan Dutt, Chemistry Department, Allahabad University, Allahabad. (2) "Colour and Constitution of Dyestuffs derived from Flourenone," by Mohit Kumar Mukerjee and Shikhibhushan Dutt, Chemistry Department, Allahabad University, Allahabad. (3) "New Trematodes of the Family *Lecithodendriidæ* Odhner, 1911, with a discussion on the classification of the family," by H.R. Mehra, Zoology Department, Allahabad University, Allahabad. (4) "Preliminary Account of New Trematodes with Ani." by S. C. Verma, Zoology Department, Allahabad University Allahabad. (5) "A Note on the Colouring Matter of the Flowers of *Lantana camera* Linn.", by Jagraj Behari Lal, Chemistry Department, Allahabad University, Allahabad.

At the meeting of the Academy held on the 16th August 1935, the President announced that the Allahabad University had renewed the grant of Rs. 500. The following papers were read and discussed :—

(1) " Further Experiments on the Fixation of Atmospheric Nitrogen in the Soil and the Utilisation of Molasses as a Fertilizer," by Prof. N. R. Dhar and Mr. S. K. Mukerjee.—The experiments of Prof. Dhar lead to the conclusion that the oxidation of the energy-rich carbohydrates present in the molasses causes the fixation of atmospheric nitrogen leading to an increase of ammonium salts and nitrates in the soil. (2) "The Nitrogen Atom and the Molecule," by L. S. Mathur. (3) "Contributions to the Digenetic Trematodes of the *Microcheroptera* of Northern India, Part III. —New Distomes the genus *Mesodendrium faust* (1919)," by B. P. Pande. (4) "On Evidences for a Lag Effect in Zeuner's Data on Saturated Water Vapour in Landolt and Bornetein's Table," by Prof. Satyendra Ray. (5) "On Evidences of Tidal Waves in an Insulated Molten Interior as obtained in some Recent Severe Earthquakes," by Prof. Satyendra Ray.

A Symposium on the 'Theory of Relativity' was held on the 17th August. Sir Shah Muhammad Sulaiman opened the discussion. In the course of his speech, he answered the criticisms of Mr. D. R. Hamilton and Mr. Satyendra Ray. He predicted that the deflection of light from a star passing the sun would be between 2″.32 and 2″.45 as against Einstein's value of 1″.75. The spectral shift of light from the limb of the sun according to his theory will be 0.00676, a value which was nearly the same as that obtained by Evershed in 1918. Einstein's theory gives the value as 0.0084. Professors A. C. Banerji, Satyendra Ray and M. N. Saha were the other speakers. Dr. Gorakh Prasad and Mr. Rama Nivas Rai also took part in the discussion.

The Indian Chemical Society :

June 1935. J. C. GHOSH AND P. C. RAKSHIT : *Oxidation of Sugars by Air in Presence of Ceric Hydroxide Sol and Cerous Hydroxide Gel.* M. R. ASWATHANARAYANA RAO : *Effect of Temperature on Selective Adsorption by Silica Gel from Binary Mixtures.* SOBHANLAL BANERJEE AND H. K. SEN : *Effect of Ultra-Violet Light on Enzymatic Reactions. Part I. Diastase.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT : *Chemical Examination of* Cuscuta Reflexa, *Roxb. Part I.—The Constituents.* JAGRAJ BEHARI LAL AND SIKHIBHUSHAN DUTT : *Metallic Uranium in Organic Synthesis. Part I.* MOHAN LAL BEHARI, KARTAR SINGH NARANG AND JNANENDRA NATH RAY : *Vasicine.* B. L. MANJUNATH AND S. SIDDAPPA : *On the Supposed Occurrence of Acids with Uneven Number of Carbon Atoms in Vegetable Oils and Fats. Part I.*—Daturic Acids from the Seeds of *Datura Stramonium*, Linn. SUSIL KUMAR RAY : *Parachor and Chemical Constitution. Part III.—The Structure of Urea and Thiourea.* NRIPENDRANATH CHATTERJEE: *Studies in Diphenyl Series. Part I.—Synthesis of Unsymmetrical Derivatives of Diphenyl.* NRIPENDRANATH CHATTERJEE : *Studies in Diphenyl Series. Part II.—A New Method of the Synthesis of 9-Hydroxyphenanthrene.*

July 1935. B. B. DEY AND (MISS) P. LAKSHMI KANTAM : *Studies in the Cotarnine Series. Part II. —The Reaction of the Aldehyde Group in Cotarnine and Benzoyl Cotarnines.* B. B. DEY AND (MISS) P. LAKSHMI KANTAM : *Studies in the Cotarnine Series. Part III.—Isomeric* bis-*Cotarninoacetones.* N.R.DHAR AND S.K.MUKHERJI: *Influence of Temperature on the Carbon-Nitrogen Ratio of Soils.* J. K. CHOWDHURY, A. C. CHAKRABARTY AND A. MAZUMDAR : *Polymerisation of some Unsaturated Fatty Acids.* U. D. BUDHLAKOTI AND K. C. MUKHERJI : *A Note on the Thiocyanogen Value of Indian Butter Fat (Ghee).* SIKHIBHUSHAN DUTT : *Putrefactive Decomposition of Bengal Silk Cocoon.* KUMUD BEHARI PATHAK :

A Note on the Condensation of ω-Bromoacetophenone with 1-o-Aminophenyl-3-phenylthiocarbamide. D.N. BEDEKER, R. P. KAUSHAL AND S. S. DESHAPANDE: *Reactivity of Carbonyl Group in γ-Pyrones and γ-Pyridones.* PULIN BEHARI SARKAR: The *Chemistry of Jute-lignin. Part VII.—The Behaviour of Organic Compounds* towards ClO_2 and its Significance on the Constitution of Lignin. P. R. KRISHNASWAMY, B. L. MANJUNATH AND S. VENKATA RAO: *Chemical Examination of the Roots of* Aristolochia Indica, *Linn. Part I.* N. G. GAJENDRAGAD AND S. K. K. JATKAR: *Equilibrium between* n-*Propyl Alcohol, Propyl Ether and Water at* 190°. U. S. KRISHNA RAO, B. L. MANJUNATH AND K. N. MENON: *Chemical Examination of the Roots of* Aristolochia Indica, *Linn. Part II.* BALBHADRA PRASAD: *Viscosity of Dilute Solutions of Non-electrolytes.*

Indian Botanical Society:

June 1935.—H. CHAUDHURI AND PUSHKAR NATH: *Studies in the Diseases of Apples in Northern India—I. A New Leaf-Spot Disease of Apples caused by* Oothecium indicum *n.sp.* R. E. COOPER AND S. A. PASHA: *The Osmotic and Suction Pressures of some species of the Mangrove Vegetation.* PUSHKAR NATH: *Studies in the Diseases of Apples in Northern India—II. A short note on Apple Scab due to* Fusicladium dendriticum *Fuckel.* K. RANGASWAMI: *On the Cytology of* Pennisetum typhoideum *Rich.* PARAM NATH BHADURI: *Studies on the Female Gametophyte in Solonaceæ.* T. S. RAGHAVAN: *Observations on the Somatic Chromosomes of* Urginia indica *Kunth.* MISS E. BAPTISTA: *Respiration of the Roots and Leaves of the Rice Plant* (Oryza sativa *L.*). N. K. TIWARY: *Observations on the Artificial Germination of* Cyathodium *Spores.* B. S. KADAM: *Inheritance of Root Colour in Rice.* H. R. BHARGAVA: *A Cheap Device for Using Safety Razor Blades for Microtome Sections.*

Reviews.

INTRODUCTION TO PHYSICAL SCIENCE. By Carl W. Miller, Ph.D., Associate Professor of Physics in Brown University, New York. (John Wiley & Sons, Inc.). Price 5*s*.

In this second edition of the book the latest developments in Physics such as Artificial Radioactivity find a place and are treated in a manner conforming to the object which the author has in view in writing it, *viz.*, to provide a one-year general course to the student who may not specialise in the subject afterwards. The method of treatment is clear and attractive avoiding all mathematics unnecessary to an elementary treatment. In these days the revolutionary advances in Physics have not only greatly influenced civilised life but have given a distinct new orientation to philosophic thinking with the result that no one claiming to be a cultured member of society can afford to be ignorant of the fundamental teachings of modern Physics. Here is a book which we can confidently recommend to one who is anxious to get a correct idea of what modern Physics means. Relativity, Quantum Theory, Wave Mechanics, Electron Diffraction and Nuclear Physics are all dealt with in a manner acceptable to the elementary student of the subject. The examples at the end of each chapter are appropriately chosen to illustrate the main points treated in the corresponding chapters. To the first year students in Indian Universities the book under review will be invaluable.

B. V.

PHYSICS FOR COLLEGE STUDENTS. By A. A. Knowlton, Ph.D. (McGraw Hill Book Company Inc., 1935.) 2nd Edition, pp. 623. Price 21*s*.

This book is written by a professor of physics in an American College, and is meant for students in American Colleges who take up an elective course of study in Physics for their graduate course. These students do not propose to continue their study of Physics beyond their one year's prescribed course, and to meet their requirements the author has written the above text-book. From it a knowledge of the essential parts of Physics can be obtained by a student in the course of one session's study of four hours a week. It is written more from a humanistic rather than a purely technical standpoint. It is shown how during the ages man has gradually acquired a mastery over his physical environment and thus been able to harness the forces of nature for his own use. During the course of this evolution he has gradually developed a mode of interpreting the natural phenomena which is incorporated in what is known as scientific explanation. In accordance with this standpoint of the author, the methods of measuring work and the different kinds of energy, mechanical, heat and electrical, are introduced early in the book. The whole of Physics is surveyed in about fifty short chapters, and the author has incorporated a large amount of modern Physics in it. The treatment is on the whole descriptive with a little of essential mathematics thrown

in. The book does not follow the usual sub-divisions of the subject into Mechanics, Sound, Light, etc., and in arranging the subject-matter the author had partly the pedagogical method of 'soaking in process' in view, *viz.*, so much and only so much of a subject is introduced as is required at that point. As its next introduction, something further is added to the material which has become part of the mental background of the student through use.

As will be seen the book is written from a novel standpoint and contains many valuable features. So far as the reviewer can judge, the book will not fit in with any of the syllabuses on Physics prescribed by the different University examinations of this country, but it can be recommended to all students preparing for the pass B.Sc. examinations, for supplementary reading.

D. M. BOSE.

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LEHRBUCH DER THEORETISCHEN PHYSIK. By G. Joos. (Akademische Verlags Gesselschaft, Leipzig.) 2nd Edition. Price RM. 24.

The attempt to present the whole of mathematical physics in a single volume is a bold venture and necessitates a careful selection of the subject-matter and sometimes a short-cut through the mathematical foundation. The particular value of this book in the opinion of the present writer lies in the fact that it shows the edifice of Physics unburdened by experimental details; yet nowhere does the mathematical deduction make the reader forget the physical conceptions. German scientific literature has always excelled in text-books on mathematical physics and it is extremely satisfactory that this series of valuable textbooks has been supplemented by this concise volume. The new English edition can be strongly recommended to the post-graduate students and teachers of this country. After a first introductory chapter, in which the mathematical tools of the Physicist are treated, the author deals with mechanics and hydrodynamics, and relativity theory in the second book. The different chapters of the third book deal with the classical theories of electrodynamics and optics, and the fourth with the electronic theory of both. Again thermodynamics which follows, is treated first in the classical way and then as kinetic theory. The seventh and last book deals with the structure of atoms and molecules and the theory of spectra, and here again a clear division between quantum theory and quantum mechanics is introduced. Wavemechanics, the wavemechanical theory of valency and dispersion and the structure of the nucleus are about the last questions which are treated.

R. SAMUEL.

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SOLID GEOMETRY. By L. Lines, M.A., B.SC. (Messrs. Macmillan & Co., Ltd., London, 1935). Pp. 292. Price 6*s*. net.

The purpose of the book appears to be partly to provide a treatise on Solid Geometry (Euclid XI), as is usually taught in our Intermediate courses, but with an elaborate collection of examples; and partly to provide a preface to the study of crystallography, and arrangement of atoms in crystals. The first six chapters deal with the theorems on Solid Geometry as are usually taught in our intermediate classes. These are followed by two chapters on Mensuration and one on Centroids. Then follow chapters on Rabatment, Polyhedra, Semi-Regular and Star-Polyhedra, Space-Lattices, Sphere-Packs, Patterns and Crystals.

The book deserves attention from every teacher of the subject on account of its wide range of problems, and variety of subjects. But we cannot help remarking that there is too much of drilling of pure geometrical methods for proving results many of which could be easier proved and better appreciated by the methods of analytical geometry and the calculus. No doubt, the use of purely geometrical methods to a certain extent is highly desirable and wholesome in these days when there may be a tendency to use the analytical machines too often; but if the methods of pure geometry are carried too far, they can only savour of pedantry on the author's part, and constitute what is often called "murdering of mathematics".

C. N. S.

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STRUCTURE NUCLÉAIRE: par G. Guében. (No. 247 of the Actualités Scientifiques et Industrielles). (Hermann et Cie, Paris, 1935.) Pp. 36. Price 10 *fr*.

The structure of the nucleus is a problem which is being actively attacked by a number of methods but we cannot say that there is any definitely established solution yet. The view that the nucleus consists of protons and electrons, the latter having combined as far as possible into α-particles, has been given up and we now think of the

nucleus as consisting of protons and neutrons. Although there are strong grounds for believing that pairs of protons and neutrons are combined as far as possible into α-particles, there are many authorities who consider the protons and neutrons to exist without such combination. Admitting, however, that there are the maximum possible α-particles formed, one proton will be left over when the atomic number is odd. Walke has tried to maintain the view that this extra proton is always combined with a neutron forming a deuton. However, the statement that any particular nuclear property is present when there is a deuton is simply equivalent to admitting the existence of the property when there is an odd proton, *i.e.*, when the atomic number is odd. The brochure under review develops Walke's proposition in detail and tries to answer some objections to that view. There is one nuclear property, however, which, in spite of its importance, has not been considered in the present book—we mean the magnetic moment of the nucleus. Experiment having shown that the deuton has a magnetic moment of 0·75 nuclear magneton, the large magnetic moments of Li, Al, etc., for example, cannot be explained if the odd proton is supposed to be combined with a neutron to form a deuton. The time is not ripe for taking any particular theory of the nucleus as finally established, but the book will serve to render one aspect familiar to French readers: the danger, however, remains that the reader may mistake the thesis of the book for the accepted view.

T. S. S.

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RAYONS COSMIQUES. par B. Rossi. (No. 248 of the Actualités Scientifiques et Industrielles.) (Hermann et Cie, Paris, 1935.) Pp. 48. Price 12 *fr.*

Our conception of the nature of cosmic rays has undergone a transformation in recent years mainly as the result of the work of J. Clay, B. Rossi and A. H. Compton. While the earlier view was that cosmic rays were very short γ-rays, the current opinion is that they almost entirely consist of particles. Compton distinguishes three groups A, B and C according to their penetrating power and shows reasons to believe that they consist of α-particles, electrons both positive and negative and protons respectively. The change of view was the result of the discovery of the latitude effect and its variation with height. The experimental facts and their significance are presented in a masterly way, the account being clear and authoritative. The language is also readable, the results being expressed definitely but with cautious reserve. Some other up-to-date accounts of cosmic ray research have recently appeared, particularly A. H. Compton's Guthrie Lecture (*Proc. Phys. Soc. London*, 1935, **47**, 747–773). Rossi's monograph can be advantageously studied side by side with Compton's paper, the two supplementing each other to the reader's great advantage. We heartily recommend this monograph to all students of modern problems in Physics and congratulate the publishers on securing such an authoritative presentation of a subject of great interest and importance.

T. S. S.

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TRANSMUTATIONS DES ÉLÉMENTS PAR DES PARTICULES ACCÉLÉREES ARTIFICIELLEMENT. Par Manuel Valadares. (No. 245 of the Actualités Scientifiques et Industrielles). (Hermann et Cie, Paris, 1935.) Pp. 32. Price 10 *fr.*

The present work contains a detailed discussion of the transmutations effected by means of artificially accelerated particles such as protons and deutons. The pioneer work of Cockcroft and Walton and of Lawrence has led to a vast extension of our knowledge of nuclear reactions and the book under review gives a clear account of these developments. The technique of producing the high energy missiles is not described. The important results obtained by α-particle bombardment and by neutron bombardment do not find a place in the book since α-particles and neutrons are not artificially accelerated. Such a separation of the results into artificial groups merely because of a name prevents us from having a synthetic view of the whole phenomena of nuclear transformations. Some of the difficulties regarding the masses of the partners in nuclear encounters discussed in the book have recently been removed by a determination of the masses of light nuclei from a study of nuclear transformations by Bethe and by Oliphant and others and Aston's confirmation of a number of these mass values. The book, however, when used along with others of the series such as that of Curie and Joliot on "Artificial Radioactivity" and J. Perrin's on "The Nuclei of Atoms" will serve as a valuable compendium of the

results obtained in a most important and fascinating field of research.

T. S. S.

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DYNAMICS OF POPULATION: SOCIAL AND BIOLOGICAL SIGNIFICANCE OF CHANGING BIRTH-RATES IN THE UNITED STATES. By Frank Lorimer and Frederick Osborn. (The Macmillan Company, New York, 1934.) Pp. xiii + 461. Price 15*s*.

Students of Social Demography will welcome this valuable addition to the scanty literature on the subject. The authors who have both practical and theoretical knowledge of the problems they are handling come to certain useful and important conclusions of the population trends in the United States. These, we hope, will be of interest not only to the American students but to all who are working on the subject throughout the world. The purpose of the book, as the sub-title implies, is a scientific study of the causes and effects of population changes.

The population of the United States is divided into classes under various headings such as national origin, occupation, social and economic status, etc. As a sequel to these a brief survey of the physical and mental characteristics of these groups is given laying stress on the variations in intellectual and cultural development. A clear line of demarcation is drawn between the rural and urban population pointing out clearly the differences in physical and mental attainments of both. With the data derived from these studies the authors have endeavoured to forecast the relative strength of the various national groups in the population of the next century.

Another important topic perused at length is the difference in reproduction rates among the groups, as the classes having higher birth-rates and greater vitality will predominate in the long run. It is also a painful reality that in areas least able to support a teeming population do we obtain maximum fertility among the groups. As a result of this investigation, the authors deduce that a sorting process is at work, establishing gradients in intellectual capacity and so intelligence ratings are bound to differ for such classes. It is abundantly clear that capacities are inherited and so a slight enhancement in the reproduction rate of these groups that have a higher average capacity for intelligence and a correspondingly slight decrease in the rate of reproduction of the less gifted groups would largely increase the number of individuals of higher capacity and considerably decrease the number of imbeciles. But it is painfully brought home to us that the present population trends are heading to the opposite result.

The other problems discussed are the causes for the observed population trends and the conclusion arrived at is that reproduction rates among the groups occupying high social levels are low. Nevertheless it is clear that economic factors and the particular method of family limitation prevalent among these groups largely determine fertility.

Another conclusion put forward is that no group with high standards of living and a knowledge of the methods of birth control can be looked forward to be self-replacing permanently unless conditions conducive to fertility intervene.

The last and perhaps the most important subject dealt with in the present volume is the possibility of social control and the suggestion that city planning and increasing the economic security of young couples holds out the greatest promise for such control.

It is needless to expatiate on the usefulness of the book to those for whom it is intended and we hope that similar careful and scientific study of the vital problems of population will be undertaken by international co-operation and collaboration.

C. N. R. R.

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TRAVANCORE GOVERNMENT ARCHÆOLOGICAL DEPARTMENT ADMINISTRATION REPORTS FOR THE YEARS 1108 M.E. AND 1109 M.E. (1932–33 AND 1933–34).

The Annual Reports of the Travancore Archæological Department are, unlike the detailed reports of the Government of India, merely brief Administration Reports. They have both the advantages and the disadvantages of brevity and cheapness and perhaps approach more nearly to punctuality than the bulkier and more detailed reports of the Government of India.

Under the head Conservation one would perhaps be justified in expecting a more detailed statement of the arrangements made and the expenditure incurred for the conservation of the ancient monuments in the State. It is difficult to believe that only Rs. 500 were spent in 1108 M.E. for this purpose and that nothing was spent in 1109 M.E. The Archæological Department

may collect the relevant information from the Department of Public Works, and publish it. Whenever any repairs are to be done to any of the ancient monuments of the State the approval and co-operation of the Archæological Department ought to be obtained, and the latter should keep a record of all such work.

The scientific work done by the Department during the years under review appears to be considerable both in quality and quantity. In the year 1108 M.E., 43 new inscriptions were examined, the earliest stone inscription being dated Kollam 301 (1126 A.D.). Brief notices of most of the inscriptions and a tabulated statement about them are given in an appendix. The report for 1109 M.E., however, is silent about inscriptions. It may be suggested that a systematic collection of epigraphical records may be made and the texts of those collected may be published from time to time. The coins studied during the year also need more detailed descriptions and clearer illustrations.

Two valuable items published in the report for 1108 M.E. are an Archæological map of the Travancore State and a table tracing in detail, of the evolution of the Vatteluttu alphabet, both of which would be found highly useful to scholars.

In the report for the year 1109 M.E. the chief piece of work described under 'Conservation' is the copying of the wall paintings found on the Gopura of the Temple at Ettumanur in North Travancore, which is ascribed to a period not later than the 16th Century A.D. The theme is that of Shiva's great dance on the destruction of the Demon Apasmara. A half-tone illustration of the central panel is given, and the painting is described as one of the great triumphs of pictorial art in Travancore.

Another piece of work connected with painting was the identification of the scenes and stories of the mural paintings in the Sri Padmanabhaswami Temple at Trivandrum. " In the vitality of the figures, and in the infinite variety of poses, gestures and emotions throbbing with life, lies the secret of their charm and attractiveness. Supreme examples of a wonderful combination of both 'Rupa' (beauty of objective realisation) and 'Rasa' (grace of emotional expression), many of these paintings have a grandeur and sublimity of conception rarely to be found in many other temples of the State."

Other pieces of useful work done during the year are: the trial excavation of some prehistoric burials at Panjapalli-Parambu near Shoranur, the discovery of a small rock-cut temple of the 11th Century A.D. near Marayur, the study of Vedic chanting and the connected hand poses, and the review of an unpublished Sanskrit manuscript on histrionics and dramaturgy, called " Bālarāmabhāratam". The author of the last-named book was Bālarāma Kulaśekhara Vanchi Bhūpāla, a Travancore king. The work is a valuable one and expounds the art of dancing and gesture somewhat on the lines of the *Abhinaya-darpana* of Nandikeśvara.

Both the reports show that Travancore is a highly valuable field for archæological investigation. It may be suggested that a systematic survey of the State may be made on a regular plan and the information about the finds published in greater detail with more illustrations.

Mr. R. V. Poduval, the Superintendent, and the Archæological Department may be congratulated on the great opportunities for study that they have before them and the interesting beginnings they have made in the years under review. Travancore is a storehouse of South Indian culture and it is to be hoped that her enlightened Government will push on the work of conserving her ancient monuments and publishing authentic information about them.

M. H. KRISHNA.

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COLLOID CHEMISTRY. By Arthur W. Thomas. (McGraw Hill Publishing Company, Ltd., 1934.) Pp. viii+512. Illustrated. Price 24*s*. net.

This volume provides a valuable introductory guide on all phases of colloid chemistry which is treated from the entirely new viewpoint of crystalloidal chemistry, taking into consideration the chemical nature and composition of the colloidal particle. The subject is comprehensively covered by eighteen chapters, each of them being devoted to a discussion of a particular aspect of colloid chemistry. The chapters on colloid optics, dialysis and ultra-filtration and preparation of colloidal solutions, deal with the experimental technique involved in the preparation, purification and study of colloids. The nature and mechanism of dialysing and ultra-filter membranes are discussed in Chapter V which also includes a very informative review of the latest theories on the nature of membrane permeability, and this

important aspect of the subject has been covered in this volume more extensively than in any other book.

A particularly striking feature of this volume is the treatment it has accorded to the two important classes of biocolloids, proteins, and carbohydrates, which will be appreciated by investigators interested in them. A study of these chapters will reveal that the latest developments in this branch, like the researches of Svedberg with his ultra-centrifuge on the molecular or micellar weight of these complex compounds, have been included. There are excellent chapters devoted to a discussion of the nature of micelles, precipitation by electrolytes, electrokinetic phenomena and sorption, aspects of colloid chemistry which will interest not only physical chemists but also others, whose work lies on the borderline between physical chemistry and biology. The fact that information of great technical significance is also to be found in the volume, particularly in chapters on soaps, foams and emulsions, will serve to extend the usefulness of this book into the field of chemical technology. The list of well-chosen and relevant references which will be found at the end of each chapter constitutes a valuable feature of the volume.

M. S.

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INDIVIDUAL HEALTH.—A Technique for the study of individual constitution and its application to Health. By E. Obermer. VOL. I. BIOCHEMICAL TECHNIQUE. By E. Obermer and Molton. (Chapman & Hall, Ltd., 1935.) Pp. xvi+244. Price 15*s*.

The tendency among physicians in the present period of transition from *Pathological* to *Preventive* medicine is to pay attention to the prevention of disease by promoting individual and public health. The physician is concerned with an enquiry into the root-cause of diseases, and he endeavours to maintain the individual in a fit condition, which will enable him to ward off diseases. Obermer proposes a technique of 'adaptational survey' which will enabie one to assess the efficiency with which a subject can adapt himself to diet, habit and environment.

The 'adaptational survey' includes a study of heredity and constitution factors, external environmental factors and the reaction of internal to environmental factors. Such a study will give a measure of the functional efficiency and any disorder in the system, strain or lowered resistance can be detected and remedied in the early stages, thus preventing any manifestation of pathological symptoms. The scheme represents the first systematic attempt of individual examination and its success will depend on the co-operation of the members of medical profession and the successful education of the general public on the value of individual health.

The present volume deals with the biochemical technique of the 'adaptational survey' and includes (1) weighing and measuring of food for 24-hour periods, (2) quantitative analysis of normal blood constituents, (3) detailed examination of each urine passed during 24-hour periods, (4) fæcal analysis, and (5) measurement of respiratory metabolism together with the assessment of specific dynamic action of foods. The results of such analyses give a quantitative picture of the dietetic and excretory habits of the subject and permits of an interpretation of endocrine, renal and gastro-intestinal efficiency.

The book is divided into two parts. Part I deals with directions for collection of specimens of ingesta, urine and fæces. Part II deals with the collection and distribution of specimens within the laboratory and also gives a description of a type of laboratory organisation for mass analysis. The methods described in this volume are mainly microphotometric, so that it is possible to carry out a large number of routine analyses with maximum accuracy compatible with minimum quantity of biological material and economy of time. A useful bibliography is appended. This part will prove to be a useful handbook to analysts interested in problems of public health, physiology and pharmacology.

N. C. D.

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THE SCIENTIFIC JOURNAL OF THE ROYAL COLLEGE OF SCIENCE. (Edward Arnold & Co., London.) Vol. V, pp. 137. Price 7*s*. 6*d*. net.

This Journal published as a neatly bound book, contains fourteen papers read during the session 1934–35 before the Imperial College Chemical Society, Natural History Society, Mathematical and Physical Society of the Royal College of Science. The fourteen papers are allotted in the order of seven, four and three among the above institutions and include a variety of interesting and important topics.

The opening discourse in the Chemistry Section is on Selenium dioxide: Professor Riley discusses at length the oxidising properties of the dioxide and its application to synthetical processes. Another noteworthy article is that on the chemistry of Gold. In this lecture recent progress in the chemistry of organo-gold compounds are treated from an advanced standpoint. In a short address Dr. Rawling has set forth some chemical themes pertaining to photographic technique and deals in an admirable manner with the curious properties of optically sensitive materials. Professor Ingold's paper on "Aliphatic Substitution" is primarily devoted to a discussion of the modern conception of valency as applied to organic compounds and the kinetics of organic reactions like hydrolysis of esters and so on. The more important subjects included in the Natural History Section are Timber Research, the Significance of Smell and the Origin of Insects. Under Timber Research, an account of the highly useful work that is carried out at the Forest Products Research Laboratory in Princes Risborough is given with a note on the structure and utility of various kinds of timber. The ingenious study on the significance of smell (some speculations on the phenomenology of olfaction) provides eminently readable matter. A clear distinction is drawn between the related sensse of olfaction and vision and the fact that smell plays a predominant role in the study of memory is stressed. The lecture on the origin of insects is at once a lucid exposition of the theory of segmentation in the Arthropoda and an unbiassed criticism of Tillyard's theory put forward in 1931. In the general trend Mr. Reynolds favours the theory proposed by Lankester in 1904. The importance of the gonopore position has not been forgotten as is usual with the theorists. It remains to be seen whether the views set forth here hold their ground against those of the rivals as this highly controversial subject must needs stimulate others to come forward to dispute.

The first paper in the Mathematical and Physical Section is on "Television" which is a highly illuminating and technical address. The disquisition on "Surface Integrals and Fluxes" is of special significance as Professor Fortesque was personally concerned with the deliberations of the sub-committee of the British Standard Institution. Here difficulties of defining the unities of permeability, susceptibility and other fundamental electro-magnetic quantities are at one stroke removed by defining these in terms of undisturbed space. The short abstract of Professor E. A. Milne's paper on the "Expanding Universe" though concise is highly interesting.

The fifth volume preserves all the merits which have characterised its precursors and is on the whole a very representative collection of excellent documents of readable matter.

C. N. R. R.

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LES CAROTENOIDES DES ANIMAUX PAR EDGAR LEDERER. (Actualites Scientifiques et Industrielles. Hermann et Cie, Editeurs, Paris.)

The author, being himself an investigator in this field, has published a succinct account of the carotinoids found in the animal kingdom. The book is based on the well-known and classical works of Palmer, Zechmeister and Verne. To begin with, is given a table of the carotinoids of plants to remind the readers of the existence of such pigments in plants. The first two chapters concern themselves with an account of the carotinoids found in several parts of the body of the invertebrates and vertebrates. The third chapter deals with the pigments specific to animals. Biological and biochemical questions are discussed in the last chapter bringing out the relationship between the carotinoids and the related pigments and Vitamin A in mammals, birds, fishes and crustaceans and its importance in medicine. The book provides a useful summary to students interested in the subject. An up-to-date bibliography is appended.

A. S. R.

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1475-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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